JC06 Rec'd PCT/PTO 25 JAN 2001

FORM PTO-1390 REV. 5-93 US DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE **TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371**		ATTORNEYS DOCKET NUMBER **P00,1911** U.S.APPLICATION NO. (if known, see 37 CFR 1.5) 09/744581
INTERNATIONAL APPLICATION NO. **PCT/DE99/02175**	INTERNATIONAL FILING DATE **14 July 1999**	PRIORITY DATE CLAIMED **05 August 1998**

TITLE OF INVENTION
METHOD FOR GENERATING AND EVALUATING A SAMPLE ENGRAVING

APPLICANT(S) FOR DO/EO/US
Ernst-Rudolf Gottfried Weidlich

Applicant herewith submits to the United States /Designated/Elected Office (DO/EO/US) the following items and other information:

1. ■ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. □ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ■ This express request to begin national examination procedures (35 U.S.C. 371(f)) at any time rather than delay.
4. ■ A proper Demand for International Preliminary Examination will be made by the 19th month from the earliest claimed priority date.
5. ■ A copy of International Application as filed (35 U.S.C. 371(c)(2))
   a. ■ is transmitted herewith (required only if not transmitted by the International Bureau).
   b. □ has been transmitted by the International Bureau.
   c. □ is not required, as the application was filed in the United States Receiving Office (RO/US)
6. ■ A translation of the International Application into English (35 U.S.C. 371(c)(2).
7. ■ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. §371(c)(3))
   a. □ are transmitted herewith (required only if not transmitted by the International Bureau).
   b. □ have been transmitted by the International Bureau.
   c. □ have not been made; however, the time limit for making such amendments has NOT expired.
   d. ■ have not been made and will not be made.
8. □ A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. ■ An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)). **Unexecuted**
10. □ A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11. to 16. below concern other document(s) or information included:

11. ■ An Information Disclosure Statement under 37 C.F.R. 1.97 and 1.98; **(PTO 1449, Prior Art, Search Report).**
12. □ An assignment document for recording. A separate cover sheet in compliance with 37 C.F.R. 3.28 and 3.31 is included. **(SEE ATTACHED ENVELOPE)**
13. ■ A FIRST preliminary amendment.
    □ A SECOND or SUBSEQUENT preliminary amendment.
14. ■ A substitute specification **- Marked up copy of Substitute Specification.**
15. □ A change of power of attorney and/or address letter.
16. ■ Other items or information:
    a. ■ Submission of Drawings **- Nine sheets of Drawings - Drawing Correction Letter**
    b. ■ **EXPRESS MAIL #EL655302262US dated January 25, 2001.**

500 Rec'd PCT/PTO 25 JAN 2001

U.S. APPLICATION NO. (if known, see 37 C.F.R. 1.5) 09/744581	INTERNATIONAL APPLICATION NO. PCT/DE99/02175	ATTORNEY'S DOCKET NUMBER P00,1911

BASIC NATIONAL FEE (37 C.F.R. 1.492(a)(1)-(5):

Search Report has been prepared by the EPO or JPO $860.00

International preliminary examination fee paid to USPTO (37 C.F.R. 1.482) $690.00

No international preliminary examination fee paid to USPTO (37 C.F.R. 1.482) but international search fee paid to USPTO (37 C.F.R. 1.445(a)(2) $760.00

Neither international preliminary examination fee (37 C.F.R. 1.482) nor international search fee (37 C.F.R. 1.445(a)(2) paid to USPTO $970.00

International preliminary examination fee paid to USPTO (37 C.F.R. 1.482) and all claims satisfied provisions of PCT Article 33(2)-(4) .... $ 96.00

ENTER APPROPRIATE BASIC FEE AMOUNT =				$860.00	
Surcharge of $130.00 for furnishing the oath or declaration later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 C.F.R. 1.492(e)).				$ 0	
Claims	Number Filed	Number Extra	Rate		
Total Claims	30 - 20 =	10	X $ 18.00	$ 180.00	
Independent Claims	2 - 3 =	0	X $ 80.00	$0	
Multiple Dependent Claims			$270.00 +	$	
TOTAL OF ABOVE CALCULATIONS =				$1040.00	
Reduction by 1/2 for filing by small entity, if applicable. Verified Small Entity statement must also be filed. (Note 37 C.F.R. 1.9, 1.27, 1.28)				$	
SUBTOTAL =				$1040.00	
Processing fee of $130.00 for furnishing the English translation later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492(f)). +				$	
TOTAL NATIONAL FEE =				$1040.00	
Fee for recording the enclosed assignment (37 C.F.R. 1.21(h). The assignment must be accompanied by an appropriate cover sheet (37 C.F.R. 3.28, 3.31). $40.00 per property +					
TOTAL FEES ENCLOSED =				$1040.00	
				Amount to be refunded	$
				charged	$

a. ■ A check in the amount of $ 1040.00 to cover the above fees is enclosed.

b. ☐ Please charge my Deposit Account No. __________ in the amount of $ ________ to cover the above fees. A duplicate copy of this sheet is enclosed.

c. ■ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 501519. A duplicate copy of this sheet is enclosed.

NOTE: **Where an appropriate time limit under 37 C.F.R. 1.494 or 1.495 has not been met, a petition to revive (37 C.F.R. 1.137(a) or (b)) must be filed and granted to restore the application to pending status.**

SEND ALL CORRESPONDENCE TO:

Schiff Hardin & Waite
Patent Department
6600 Sears Tower
Chicago, Illinois 60606

Brett A. Valiquet
SIGNATURE

Brett A. Valiquet
NAME

27,841
Registration Number

09/744581

500 Rec'd PCT/PTO 25 JAN 2001

BOX PCT

IN THE UNITED STATES ELECTED OFFICE

OF THE UNITED STATES PATENT AND TRADEMARK OFFICE

UNDER THE PATENT COOPERATION TREATY-CHAPTER II

PRELIMINARY AMENDMENT

APPLICANT: ERNST-RUDOLF GOTTFRIED WEIDLICH

DOCKET NO: P00,1911

SERIAL NO:

GROUP ART UNIT:

EXAMINER:

INTERNATIONAL APPLICATION NO: PCT/DE99/02175

INTERNATIONAL FILING DATE: 14 July 1999

INVENTION: **"METHOD FOR GENERATING AND EVALUATING A SAMPLE ENGRAVING"**

Assistant Commissioner for Patents,
Washington, D.C. 20231

Sir:

As a Preliminary Amendment for entry into the National Stage for the above-identified PCT application, the following is submitted:

IN THE DRAWINGS:

Please make the drawing corrections shown in the attached Drawing Correction Letter.

IN THE ABSTRACT:

Please add the following Abstract:

--In a method for making and evaluating a sample engraving in an electronic engraving machine for engraving printing cylinders for rotogravure, during a sample engraving, trial cups are engraved for predetermined tone values by an engraving element. After the sample engraving, a video camera is positioned at a predetermined axial measuring position, and a video image of the trial cups is recorded. The deviations of position of a measuring point of a selected trial cup are determined from a reference point as position errors Δx_M, Δy_M. The position errors Δx_M, Δy_M are then corrected by axially displacing the video camera to a new measuring position and/or by rotating the printing cylinder. Afterwards, the geometric values of the trial cup are measured and are compared with the geometric values of the predetermined tone values. The engraving control signal for guiding the engraving element is calibrated according to the result of the comparison such that the engraved tone values correspond to the predetermined tone values.--

IN THE SPECIFICATION:

A Substitute Specification is attached herewith together with a marked copy of the Substitute Specification showing the changes made. No new matter is introduced in this Substitute Specification. A marked up copy showing the additions and deletions is enclosed.

IN THE CLAIMS:

On page 17 of the claims, delete "Patent Claims" and substitute --**I CLAIM AS MY INVENTION**--.

Please cancel claims 1-29 without prejudice.

Please substitute new claims 30-59 as follows:

30. A method for generating and evaluating a sample cut in an electronic engraving machine for engraving printing cylinders for rotogravure, comprising the steps of:

forming an engraving control signal for driving an engraving stylus of an engraving element from engraving data which represent hues to be engraved between "light" and "dark" and a periodic raster signal for generating an engraving raster;

with the engraving stylus engraving a sequence of cups arranged in the engraving raster into the printing cylinder engraving line by engraving line, geometry values of said cups determining the engraved hues;

engraving sample cups for predetermined hues before actual engraving;

positioning a video camera to a predetermined, axial measurement position and registering a video image of the sample cups with the video camera;

selecting at least one of the engraved sample cups;

identifying a positional deviation of a measurement location of the selected sample cup from a reference location in the video image as a position error;

correcting the identified position error by at least one of axial displacement of the video camera into a new measurement position and turning the printing

cylinder such that the measurement location of the selected sample cup lies at least in a region of the reference location of the video image;

subsequently measuring geometry values of at least the selected sample cup and comparing them to geometry values of the predetermined hues; and

calibrating the engraving control signal dependent on a result of the comparison so that the engraved hues correspond to the predetermined hues.

31. The method according to claim 30 wherein a sample cup representing a mid-hue between "light" and "dark" is selected.

32. The method according to claim 30 wherein the measurement location is an area mid-point of the selected sample cup.

33. The method according to claim 30 wherein the measurement location is a mid-point of one of the transverse diagonals and of the longitudinal diagonals of the selected sample cup.

34. The method according to claim 30 wherein the measurement location is a mid-point of one of a pilot cut and of a web of the selected sample cup.

35. The method according to claim 30 wherein the reference location for determining the positional

deviation of the selected sample cup in the video image lies in a middle of the image.

36. The method according to claim 30 wherein the reference location for determining the positional deviation of the selected sample cup in the video image is a coordinate origin of a measurement coordinate system in the video image.

37. The method according to claim 30 wherein the video image is subdivided into pixels; and a position of the pixels in the video image is defined by coordinates of a video coordinate system allocated to the video image.

38. The method according to claim 30 wherein
the video image is subdivided into pixels;
a measurement field displaceable across the video image is generated;
the measurement field comprises at least one measurement line with a plurality of pixels whose position in the video image is defined by coordinates of a video coordinate system; and
a length of a measurement distance in the video image is determined as a plurality of pixels of the measurement line.

39. The method according to claim 38 wherein the measurement field is designed stripe-shaped.

40. The method according to claim 38 wherein the measurement field can be arbitrarily oriented in the video image.

41. The method according to claim 38 wherein the measurement distance corresponds to the spacing of two contours belonging to a sample cup from one another.

42. The method according to claim 38 wherein contours of the sample cup are recognized by an automatic evaluation of the video image.

43. The method according to claim 42 wherein contours of the sample cup are recognized by means of at least one measurement line of the measurement field.

44. The method according to claim 43 wherein

every pixel of the video image has a video datum allocated to it that identifies whether a corresponding pixel is a component part of the sample cup or not;

video data of respectively two successive pixels of the measurement line of the measurement field are investigated for a change; and

an identified change of the video data is recognized as a contour.

45. The method according to claim 30 wherein the selected sample cup is automatically recognized in the video image with assistance of a displaceable measurement field.

46. The method according to claim 45 wherein a size of a cup area of the selected sample cup is prescribed;

the measurement field is defined having a size corresponding at least to the cup area of the selected sample cup;

the measurement field is shifted across the video image from sample cup to sample cup;

the cup area of the respective sample cup is measured in every position of the measurement field and compared to the prescribed cup area; and

a sample cup is recognized as selected sample cup given at least approximate area coincidence.

47. The method according to claim 46 wherein the size of the cup area of the selected sample cup is prescribed as a plurality of pixels;

the measurement field comprises a plurality of measurement lines aligned parallel to one another;

the cup area of a sample cup is determined by adding up pixels in the individual measurement lines that fall into the cup area; and

the prescribed plurality of pixels is compared to the measured plurality of pixels in the area comparison.

48. The method according to claim 30 wherein a measurement location of the selected sample cup and its position in the video image is automatically determined with the assistance of a displaceable measurement field.

49. The method according to claim 48 wherein the measurement location is an area mid-point of the selected sample cup; and one of a transverse diagonal and a longitudinal diagonal of the selected sample cup is measured with the measurement field as a measurement distance, whereby the area mid-point derives as one of half of the transverse diagonal and half of the longitudinal diagonal.

50. The method according to claim 30 wherein

two printing cylinders coupled to one another are engraved with a respective engraving element;

the engraving elements are arranged on a shared engraving carriage;

a video camera is allocated to each engraving element;

the first video camera is positioned to a predetermined, first measurement position;

an axial position error of the first video camera is measured in the predetermined, first measurement position;

the measured axial position error of the first video camera is corrected by displacing the shared engraving carriage into a new, first measurement position;

geometry values of the sample cups engraved on the first printing cylinder are measured at the new, first measurement position of the first video camera;

an axial position error of the second video camera in a momentary position of the shared engraving carriage is measured;

a new axial position error is calculated for the second video camera;

the calculated, axial position error of the second video camera is corrected by displacing the shared engraving carriage into a new, second measurement position; and

geometry values of the sample cups engraved on the second printing cylinder are measured at the new, first measurement position of the first video camera.

51. The method according to claim 30 wherein sample cups for the hues "light", "dark" and at least one "mid-hue" are engraved in the sample engraving.

52. The method according to claim 30 wherein the sample cups for the hues "light", "dark" and "mid-hue" are respectively engraved on neighboring engraving lines.

53. The method according to claim 30 wherein at least one sample cup is engraved on each engraving line.

54. The method according to claim 30 wherein the geometry values to be measured are at least one of transverse diagonals, longitudinal diagonals, pilot cuts, web widths and cup areas of the engraved sample cups.

55. The method according to claim 30 wherein a stripe-shaped measurement field is provided having its longitudinal expanse arranged transversely, to a path of the web in the measurement coordinate system for measuring web widths.

56. The method according to at least one of the claims 30 wherein

a measurement field is provided having a plurality of measurement lines arranged parallel to one another;

measured results achieved with the individual measurement lines are compared to one another; and

for enhancing measuring dependability, a measured result of a measurement line is forwarded only given agreement of the measured results compared to one another.

57. The method according to claim 30 wherein

a measurement field is provided having a plurality of measurement lines arranged parallel to one another;

measured results achieved with the individual measurement lines are subjected to an extreme value selection; and

only one of a greatest and smallest measured result is forwarded.

58. The method according to claim 30 wherein a measurement field is employed both for measurement of positional deviation of the selected sample cup as well as for measurement of geometry values of the sample cups.

59. A method for generating and evaluating a sample cut in an electronic engraving machine for engraving printing cylinders for rotogravure, comprising the steps of:

forming an engraving control signal for driving an engraving element from engraving data which represent hues to be engraved between "light" and "dark" and a periodic raster signal for generating an engraving raster;

with the engraving stylus engraving a sequence of cups arranged in the engraving raster into the printing cylinder engraving line by engraving line, geometry values of said cups determining the engraved hues;

engraving sample cups for predetermined hues before actual engraving;

positioning a video camera to a predetermined, axial measurement position and registering a video image of the sample cups with the video camera;

selecting at least one of the engraved sample cups;

identifying a positional deviation of a measurement location of the selected sample cup from a reference location in the video image as a position error;

correcting the identified position error by moving at least one of the video camera and the printing cylinder such that the measurement location of the selected sample cup lies at least in a region of the reference location of the video image;

subsequently measuring geometry values of at least the selected sample cup and comparing them to geometry values of the predetermined hues; and

calibrating the engraving control signal dependent on a result of the comparison so that the engraved hues correspond to the predetermined hues.

REMARKS

An Abstract has been added in accordance with U. S. practice.

The specification has been amended to place it in appropriate form for U. S. prosecution. The same is true of the drawings.

New claims are presented drawn in accordance with U.S. practice. Claims 30-58 correspond to the original German prosecuted PCT claims. However, reference numerals have been removed and multiple dependencies have been removed in accordance with U. S. practice. Also, claims have been clarified where appropriate in accordance with proper antecedent basis and the English language.

None of the above amendments to the claims have narrowed the claims and none of the above amendments were for patentability reasons. Therefore, none of these amendments would result in a prosecution history estoppel in accordance with the Festo decision.

An Information Disclosure Statement is enclosed.

Respectfully submitted,

(Reg.No. 28,982)

Brett A. Valiquet
Schiff Hardin & Waite
Patent Department
71st Floor Sears Tower
Chicago, Illinois 60606
(312) 258-5786
Attorneys for Applicants

#3

JC08 Rec'd PCT/PTO 07 MAR 2001

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

SECOND PRELIMINARY AMENDMENT AND SUBMITTAL OF EXECUTED DECLARATION

APPLICANT(S): ERNST-RUDOLF GOTTFRIED WEIDLICH

SERIAL NO.: 09/744,581 GROUP ART UNIT:

FILED: January 25, 2001 EXAMINER:

TITLE: **"METHOD FOR GENERATING AND EVALUATING A SAMPLE ENGRAVING"**

Assistant Commissioner for Patents,

Washington, D. C. 20231

SIR:

As a Second Preliminary Amendment in the above-identified case, the following is submitted:

IN THE SPECIFICATION:

Please enter the enclosed second substitute specification. A marked up copy showing changes to the first substitute specification is enclosed. No new matter is involved.

IN THE CLAIMS:

Please amend claims 30, 31, 51, 52 and 59 as follow. A markup showing changes to the claims is attached.

03/09/2001 UEBUVIDE 00000143 09744581

01 FC:154 130.00 OP

30. (Amended) A method for generating and evaluating a sample cut in an electronic engraving machine for engraving printing cylinders for rotogravure, comprising the steps of:

forming an engraving control signal for driving an engraving stylus of an engraving element from engraving data which represent tone values to be engraved between "light" and "dark" and a periodic raster signal for generating an engraving screen;

with the engraving stylus engraving a sequence of cups arranged in the engraving screen into the printing cylinder engraving line by engraving line, geometry values of said cups determining the engraved tone values;

engraving sample cups for predetermined tone values before actual engraving;

positioning a video camera to a predetermined, axial measurement position and registering a video image of the sample cups with the video camera;

selecting at least one of the engraved sample cups;

identifying a positional deviation of a measurement location of the selected sample cup from a reference location in the video image as a position error;

correcting the identified position error by at least one of axial displacement of the video camera into a new measurement position and turning the printing cylinder such that the measurement location of the selected sample cup lies at least in a region of the reference location of the video image;

subsequently measuring geometry values of at least the selected sample cup and comparing them to geometry values of the predetermined tone values; and

calibrating the engraving control signal dependent on a result of the comparison so that the engraved tone values correspond to the predetermined tone values.

31. (Amended) The method according to claim 30 wherein a sample cup representing a mid-tone value between "light" and "dark" is selected.

51. (Amended) The method according to claim 30 wherein sample cups for the tone values "light", "dark" and at least one "mid-tone value" are engraved in the sample engraving.

52. (Amended) The method according to claim 30 wherein the sample cups for the tone values "light", "dark" and "mid-tone value" are respectively engraved on neighboring engraving lines.

59. (Amended) A method for generating and evaluating a sample cut in an electronic engraving machine for engraving printing cylinders for rotogravure, comprising the steps of:

forming an engraving control signal for driving an engraving element from engraving data which represent tone values to be engraved between "light" and "dark" and a periodic screen signal for generating an engraving screen;

with the engraving stylus engraving a sequence of cups arranged in the engraving screen into the printing cylinder engraving line by engraving line, geometry values of said cups determining the engraved tone values;

engraving sample cups for predetermined tone values before actual engraving;

positioning a video camera to a predetermined, axial measurement position and registering a video image of the sample cups with the video camera;

selecting at least one of the engraved sample cups;

identifying a positional deviation of a measurement location of the selected sample cup from a reference location in the video image as a position error;

correcting the identified position error by moving at least one of the video camera and the printing cylinder such that the measurement location of the selected sample cup lies at least in a region of the reference location of the video image;

subsequently measuring geometry values of at least the selected sample cup and comparing them to geometry values of the predetermined tone values; and

calibrating the engraving control signal dependent on a result of the comparison so that the engraved tone values correspond to the predetermined tone values.

REMARKS

After further review of the specification, Applicants have decided that there are improved translations for certain German words, namely the German word "tonwert" and the German word "raster". These improved translations have been included in the new substitute specification and in the claim amendments.

Attached hereto is a marked-up version of the changes made to the specification and claims by the current amendment.

Also enclosed is the executed Declaration.

Respectfully submitted,

Brett A. Valiquet (Reg). #27,841

Brett A. Valiquet
Schiff Hardin & Waite
Patent Department
6600 Sears Tower
Chicago, Illinois 60606
Telephone: 312-258-5786
Attorneys for Applicant
CUSTOMER NO. 26574

I hereby certify that this correspondence is being deposited with the United States Postal Service as First Class Mail in an envelope addressed to: Assistant Commissioner for Patents, Washington, D. C. 20231 on March 5, 2001.

Brett A. Valiquet
Name of Applicants' Attorney

Brett A. Valiquet
Signature

March 5 , 2001
Date

This redlined draft, generated by CompareRite (TM) - The Instant Redliner, shows the differences between -
original document : P:\H&S C DRIVE\MYFILES\844\PCT\P001911-ORIGINAL CLAIMS.WPD
and revised document: P:\H&S C DRIVE\MYFILES\844\AMENDMEN.DIR\P001911-CLAIMS.WPD

CompareRite found 27 change(s) in the text

Deletions appear as Strikethrough text
Additions appear as Bold text

VERSION WITH MARKINGS TO SHOW CHANGES MADE

~~30.~~ **30. (Amended)** A method for generating and evaluating a sample cut in an electronic engraving machine for engraving printing cylinders for rotogravure, comprising the steps of:

forming an engraving control signal for driving an engraving stylus of an engraving element from engraving data which represent ~~hues~~ **tone values** to be engraved between "light" and "dark" and a periodic raster signal for generating an engraving ~~raster~~ **screen**;

with the engraving stylus engraving a sequence of cups arranged in the engraving ~~raster~~ **screen** into the printing cylinder engraving line by engraving line, geometry values of said cups determining the engraved ~~hues~~ **tone values**;

engraving sample cups for predetermined ~~hues~~ **tone values** before actual engraving;

positioning a video camera to a predetermined, axial measurement position and registering a video image of the sample cups with the video camera;

selecting at least one of the engraved sample cups;

identifying a positional deviation of a measurement location of the selected sample cup from a reference location in the video image as a position error;

correcting the identified position error by at least one of axial displacement of the video camera into a new measurement position and turning the printing cylinder such that the measurement location of the selected sample cup lies at least in a region of the reference location of the video image;

subsequently measuring geometry values of at least the selected sample cup and comparing them to geometry values of the predetermined ~~hues~~ **tone values**; and

calibrating the engraving control signal dependent on a result of the comparison so that the engraved ~~hues~~ **tone values** correspond to the predetermined ~~hues~~ **tone values**.

31. **(Amended)** The method according to claim 30 wherein a sample cup representing a mid-~~hue~~ **tone value** between "light" and "dark" is selected.

51. **(Amended)** The method according to claim 30 wherein sample cups for the ~~hues~~ **tone values** "light", "dark" and at least one "mid-~~hue~~ **tone value**" are engraved in the sample engraving.

52. **(Amended)** The method according to claim 30 wherein the sample cups for the ~~hues~~ **tone values** "light", "dark" and "mid-~~hue~~ **tone value**" are respectively engraved on neighboring engraving lines.

59. **(Amended)** A method for generating and evaluating a sample cut in an electronic engraving machine for engraving printing cylinders for rotogravure, comprising the steps of:

forming an engraving control signal for driving an engraving element from engraving data which represent ~~hues~~ **tone values** to be engraved between "light" and "dark" and a periodic ~~raster~~ **screen** signal for generating an engraving ~~raster~~ **screen**;

with the engraving stylus engraving a sequence of cups arranged in the engraving ~~raster~~ **screen** into the printing cylinder engraving line by engraving line, geometry values of said cups determining the engraved ~~hues~~ **tone values**;

engraving sample cups for predetermined ~~hues~~ **tone values** before actual engraving;

positioning a video camera to a predetermined, axial measurement position and registering a video image of the sample cups with the video camera;

selecting at least one of the engraved sample cups;

identifying a positional deviation of a measurement location of the selected sample cup from a reference location in the video image as a position error;

correcting the identified position error by moving at least one of the video camera and the printing cylinder such that the measurement location of the selected sample cup lies at least in a region of the reference location of the video image;

subsequently measuring geometry values of at least the selected sample cup and comparing them to geometry values of the predetermined ~~hues~~ **tone values**; and

calibrating the engraving control signal dependent on a result of the comparison so that the engraved ~~hues~~ **tone values** correspond to the predetermined ~~hues~~ **tone values**.

SPECIFICATION

TITLE

METHOD FOR GENERATING AND EVALUATING A SAMPLE ENGRAVING

BACKGROUND OF THE INVENTION

The invention is in the field of electronic reproduction technology and is directed to a method for generating and evaluating a sample engraving in an electronic engraving machine for engraving printing cylinders for rotogravure.

In an electronic engraving machine, an engraving element with an engraving stylus as a cutting tool moves in an axial direction along a rotating printing cylinder. The engraving stylus controlled by an engraving control signal cuts a sequence of cups arranged in an engraving screen into the generated surface of the printing cylinder. The engraving control signal is formed by superimposition of image signal values, which represent the tone values to be engraved between "light" white and "dark" black, with a periodic screen signal. Whereas the screen signal effects a vibrating lifting motion of the engraving stylus for generating the engraving screen, the image signal values determine the geometry values of the cups engraved into the printing cylinder.

The engraving control signal must be calibrated so that the engraved tone values correspond to the hues defined by the image signal values. For that purpose, what is referred to as a sample engraving is implemented before the actual engraving, sample cups for predetermined tone values being engraved into the printing cylinder in this sample engraving.

After the sample engraving, a measuring instrument is positioned on the engraved sample cups and their geometry values such as, for example, the transverse diagonals and longitudinal diagonals are measured.

The measured geometry values of the sample cups are then compared to the predetermined geometry values. Setting values are obtained from the comparison with which the engraving control signal is calibrated such that the geometry values of

the cups generated in the later engraving coincide with the geometry values required for reproduction with proper tone values.

The PCT patent application serial number PCT/DE 98/01441 has already disclosed that a video camera with an image evaluation unit be employed for determining the geometry values of engraved sample cups, the geometry values in a video image of the sample cups registered with the video camera being measured with said image evaluation unit.

A prerequisite for an exact measurement is that the sample cups fall completely into the image excerpt registered by the video camera after a manual or automatic positioning of the video camera given optimum image resolution. This condition is not always met in practice, particularly after changing engraving styli, and mismeasurements are the result.

SUMMARY OF THE INVENTION

It is therefore an object of the present invention to improve a method for generating and evaluating a sample engraving in an electronic engraving machine for engraving printing cylinders for rotogravure with respect to the positioning of a measuring instrument, particularly a video camera, such that a high-precision, automatic measuring of the sample cups generated in the sample engraving is assured.

According to the method of the present invention for generating and evaluating a sample cut in an electronic engraving machine for engraving printing cylinders for rotogravure, an engraving control signal for driving an engraving stylus of an engraving element is formed from engraving data which represent tone values to be engraved between "light" and "dark" and a periodic screen signal for generating an engraving screen. With the engraving stylus, a sequence of cups arranged in the engraving screen is engraved into the printing cylinder engraving line by engraving line, geometry values of the cups determining the engraved tone values. Sample cups for predetermined tone values are engraved before actual engraving. A video camera is positioned to a predetermined, axial measurement position and with which a video

image of the sample cups is registered. One of the engraved sample cups is selected. A positional deviation of a measurement location of the selected sample cup from a reference location in the video image is identified as a position error. The identified position error is corrected by at least one of axial displacement of the video camera into a new measurement position and by turning the printing cylinder such that the measurement location of the selected sample cup lies at least in a region of the reference location of the video image. Geometry values of at least the selected sample cup are subsequently measured and these geometry values are compared to geometry values of the predetermined tone values. The engraving control signal is calibrated dependent on a result of the comparison such that the engraved tone values correspond to the predetermined tone values.

The invention is explained in greater detail below on the basis of Figures 1 through 13.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 shows schematically an electronic engraving machine for engraving printing forms with a first exemplary embodiment for the arrangement of a measuring instruments for measuring engraved sample cups;

Figure 2 is a video image of engraved sample cups before correction of positioning errors of a video camera;

Figure 3 shows the formation of a stripe-shaped measuring field;

Figure 4 shows the formation of a quadratic measuring field;

Figure 5 is a graphic presentation for automatically determining a measuring distance within a measurement field;

Figure 6 is a graphic presentation for measuring the positioning errors of a sample cup in one coordinate direction;

Figure 7 is a graphic presentation for measuring the positioning errors of a sample cup in the other coordinate direction;

Figure 8 is a video image of engraved sample cups after a correction of positioning errors of a video camera;

Figure 9 is a graphic presentation for measuring a pilot cut;

Figure 10 is a graphic presentation for measuring a web width;

Figure 11 shows schematically an electronic engraving machine for engraving printing forms with a second exemplary embodiment for the arrangement of a measuring instruments for measuring engraved sample cups;

Figure 12 shows the method sequence given an engraving machine; and

Figure 13 shows the method sequence given an engraving machine working in twin mode.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Figure 1 schematically shows an electronic engraving machine for engraving printing forms for rotogravure with a first exemplary embodiment for a measuring instrument for measuring sample cups generated in a sample engraving. For example, the engraving machine is a HelioKlischograph® of Hell Gravure Systems GmbH, Kiel, Germany.

A printing cylinder 10 is rotationally driven by a cylinder drive 2. The engraving on the printing cylinder 1 occurs with an engraving element 3 having an engraving stylus 4 as cutting tool. The engraving element 3 is located on an engraving carriage 5 that can be moved in axial direction of the printing cylinder 1 by an engraving carriage drive 7 on the basis of a spindle 6.

The engraving stylus 4 cuts a sequence of cups arranged in an engraving screen into the generated surface of the rotating printing cylinder 1 engraving line by engraving line while the engraving carriage 5 with the engraving element 3 moves along the printing cylinder 1 in the axial direction.

The engraving stylus 4 is controlled by an engraving control signal GS. The engraving control signal GS is formed in an engraving amplifier 8 by superimposition of a periodic screen signal R with image signal values B that represent the tone values of the cups to be engraved between "light" and "dark". Whereas the periodic screen signal R effects a vibrating lifting motion of the

engraving stylus 4 for generating the engraving screen, the image signal values B corresponding to the tone values to be engraved determine the geometry values of the engraved cups.

The analog image signal values B are acquired in a D/A converter 9 from engraving data GD that are deposited in an engraving data memory 10 and read therefrom engraving line by engraving line and supplied to the D/A converter 9. Each engraving location in the engraving screen has an engraving datum GD of at least one byte allocated to it that, as engraving information, contains the tone value tone value between "light" and "dark" to be engraved.

The generated surface of the printing cylinder 1 has an engraving coordinate system allocated to it whose abscissa axis is oriented in axial direction of the printing cylinder 1 (feed direction of the engraving element) and whose ordinate axis is oriented in circumferential direction of the printing cylinder 1 (direction of the engraving lines). The engraving coordinates x_G and y_G of the engraving coordinate system define the engraving locations for the cups on the printing cylinder 1. The engraving carriage drive 7 generates the engraving coordinates x_G that determine the axial positions of the engraving lines on the printing cylinder 1. A position sensor 11 mechanically coupled to the cylinder drive 2 generates the corresponding engraving coordinates y_G that indicate the relative circumferential positions of the rotating printing cylinder 1 relative to the engraving stylus 4. The engraving coordinates x_G and y_G of the engraving locations are supplied to a controller 14 via lines 12, 13.

The controller 14 controls the addressing and the readout of the engraving data GD from the engraving data memory 10 dependent on the engraving coordinates x_G and y_G of the current engraving locations via a line 15. The controller 14 also generates the screen signal R on a line 16 with the frequency required for generating the engraving screen. For axial positioning of the engraving element 3 relative to the printing cylinder 1 and for controlling the feed motion of the engraving element 3 during engraving, corresponding control commands S_1 on a line 17 to the engraving

carriage drive 7 are generated in the controller 14. Further control commands S_2 on a line 18 control the cylinder drive 2.

For engraving sample cups 19 on juxtaposed engraving lines 21 in a sample engraving region 20 of the printing cylinder 1 that is not used for the later engraving, the engraving machine comprises a sample engraving computer 22 that supplies the required engraving data GD* to the D/A converter 9.

For measuring the geometry values of the sample cups 19 generated in the sample engraving, a measuring carriage 23 displaceable in the axial direction of the printing cylinder 1 and having a video camera 24 for recording a video image of the sample cups 19, an image evaluation unit 26 connected to the video camera 24 via a line 25 for measuring the registered sample cups 19 and a control monitor 27 for monitoring the video image are present in the first exemplary embodiment shown in Figure 1.

The geometry values of the sample cups to be measured can, for example, be the transverse diagonals, the longitudinal diagonals, the widths of the pilot cuts and the web widths.

The video image of the sample cups 19 can be made given a stationary printing cylinder 1 or during the rotation of the printing cylinder 1, given a corresponding synchronization. The measuring carriage 23 with the video camera 24 can be axially positioned onto the sample cups 19 generated in the sample engraving region, being positioned with a spindle 28 and a measuring carriage drive 29. The measuring carriage drive 29 is controlled by the controller 140 by control commands S_3 on a line 30.

The geometry values of the sample cups 19 measured in the image evaluation unit 26 on the basis of the video image are transmitted to the sample engraving computer 22 via a line 31. Setting values for calibrating the engraving amplifier 8 are acquired in the sample engraving computer 22 by comparing the measured, actual geometry values to the predetermined, rated geometry values. The engraving control signal GS in the engraving amplifier 8 is then calibrated with the

setting values, which are supplied to the engraving amplifier 8 via a line 32, such that the cups actually generated in the later engraving of the printing cylinder 1 correspond to the cups required for an engraving with correct tone values.

The calibration of the engraving control signal GS can occur automatically before the engraving or online during the engraving. The calibration, however, can also be manually implemented in that the sample engraving computer 22 merely displays the setting values that have been determined, these then being manually transferred to the engraving amplifier 8.

The generation and evaluation of a sample engraving sequences according to the following method steps:

In a method step **[A]** for the implementation of the sample engraving, the engraving element 3 with the engraving carriage 5 is axially displaced from a zero position onto a rated position at which the first engraving line 21' is to be engraved within the sample engraving region 20 provided for the sample engraving, being manually or automatically displaced with the engraving carriage drive 7.

In a method step **[B]**, the sample engraving computer 22 calls, for example, the engraving data GD* for the rated tone values "dark", "light" and for at least one "mid-tone value" between "light" and "dark" for engraving the sample cups 19. The engraving data GD* that have been called are converted into the engraving control signal GS for the engraving element 3. Proceeding from the first engraving line 21', the engraving element 3 respectively engraves at least one sample cup 19 for "light", "dark" and "mid-tone value" on juxtaposed engraving lines 21. A plurality of sample cups 19 of the same tone value are preferably engraved in circumferential direction on each engraving line 21, 21' within the expanse of the sample engraving region 20.

In a method step **[C]**, the video camera 24 with the measuring carriage 23 is manually or automatically displaced with the measuring carriage drive 29 from a zero position onto a predetermined measuring position that corresponds to the rated position of that engraving line 21 whose sample cups 19 are to be measured, for

example onto the rated position of the first engraving line 21', being displaced for measuring the geometry values of the engraved sample cups 19.

Let the video camera 24 be adjusted such that, given coincidence of the measuring position and the rated position of an engraving line 21, the sample cups 19 of this engraving line to be measured lie on a reference location in the middle of the video image, for example on the ordinate axis of a measurement coordinate system with the coordinate origin in the middle of the image. It is thereby assured that the sample cups 19 are fully covered by the video camera 24 given optimum image resolution in order to achieve a high measuring precision.

In practice, however, the engraving stylus 4 must be occasionally replaced. Without involved readjustment, the original engraving stylus position can be lost when changing engraving styli, and the sample cups 19 are engraved at engraving locations that deviate from the rated engraving locations defined by the engraving coordinate values x_G and y_G. In this case, the sample cups 19 are engraved on engraving lines 21, 21' whose axial actual positions are offset compared to the predetermined rated positions. Given displacement of the video camera 24 onto a predetermined measuring position that coincides with a predetermined rated position of an engraving line 21, 21', positive and negative position errors Δx_M and Δy_M of the sample cups 19 engraved on the offset engraving line 21, 21' compared to the measurement coordinate system therefore appear in the video image. Due to these position errors Δx_M and Δy_M, it can therefore occur that the sample cups 19 do not fully lie in the video image given optimum image resolution, and imprecisions in the measurement of the geometry values of the sample cups are the result.

In order to improve the measuring precision, it is therefore proposed that one of the engraved sample cups 19 be selected, the position errors Δx_M and Δy_M of the selected sample cup being measured in a method step **[D]** as coordinate-related distances of a measuring location of the sample cup from a reference location in the video image, for example relative to the coordinate origin of the measurement coordinate system, and the identified position errors Δx_M and Δy_M are corrected before

measuring the geometry values of at least the selected sample cup in a method step **[E]** by displacing the video camera 24 onto a new measuring position and/or by turning the printing cylinder 1 such that the measuring location of the selected sample cup 19' lies in the reference location of the video image.

In the method step **[D]**, the position errors Δx_M and Δy_M of the measuring location of the selected sample cup 19' that have arisen in the positioning of the video camera 24 to a predetermined measuring position are first measured relative to the coordinate origin of the measurement coordinate system in the image evaluation unit 26 on the basis of the registered video image.

For example, a sample cup 19 that represents a "mid-tone value" M or, on the other hand, some other sample cup 19 as well should therefore be selected as sample cup 19' whose measuring location is to be shifted into the coordinate origin of the measurement coordinate system. Dependent on which geometry values are to be determined, the mid-point of the cup area, the mid-point of the transverse diagonals or longitudinal diagonals of the sample cup or, on the other hand, the mid-point of a web or pilot cut to be measured should be defined as a measuring location of the selected sample cup 19'. The measurement of the position errors Δx_M and Δy_M of the selected sample cup in the video image is explained on the basis of Figure 2.

Figure 2 shows a registered video image 35 of the engraved sample cups 19 with the orthogonal engraving screen composed of horizontal and vertical screen lines, whereby the vertical screen lines are the engraving lines 21. For example, engraved sample cups 19 for "light" L, "dark" T and "mid-tone value" M are shown on three juxtaposed engraving lines 21. The centers of gravity of the sample cups 19 lie on the intersections of the screen lines of the engraving screen.

The video image 35 is composed of a plurality of pixels 36 whose positions in the video image 35 are defined by the image coordinates x_V and y_V of an image coordinate system 37 allocated to the video image 35. The coordinate axes of the image coordinate system 37 is directed in the longitudinal and the transverse expanse of the video image 35, and the coordinate origin 36 lies in a corner point of

the video image 35. The coordinate axes of the measurement coordinate system 4 are aligned parallel to the coordinate axes of the image coordinate system 37. The coordinate origin 39 of the measurement coordinate system 40, which lies in the mid-point of the video image 35 has the image coordinates x_{VM} and y_{VM} in the image coordinate system 37. The following coordinate-related relationship thus derives:

$$x_M = x_V - x_{VM}$$

$$y_M = y_V - y_{VM}$$

For example, the sample cup 19' with the mid-point of the cup area as measuring location 41 that has the image coordinates x_{VB} and y_{VB} in the image coordinate system 37 is selected. The position errors Δx_M and Δy_M of the selected sample cup 19' in the measurement coordinate system 40 thus derive as:

$$\Delta x_M = x_{VB} - x_{VM}$$

$$\Delta y_M = y_{VB} - y_{VM}$$

Every pixel 36 has a video datum VD of, for example, 8 bits characterizing the respective gray scale value allocated to it, so that a total of 254 gray scale values can be distinguished between “black” VD=0 and “white” VD=255. By filtering or with thresholds, the gray scale values can be reduced such to two values that, for example, the video datum VD = 0 is allocated to those pixels that fall onto the generated surface of the printing cylinder 1 and the video datum VD = 1 is allocated to those pixels that fall onto the cup areas of the sample cup 19. The contour (density discontinuity) of a cup area is thereby characterized by the change of the video datum from “0" to “1" or from “1" to “0".

For automatically determining the image coordinate values x_{VB} and y_{VB} of the measuring location 41 of the selected sample cup 19' in the image coordinate system 37, for example a stripe-shaped measurement field 42 is defined that can be shifted across the video image and that can be aligned with an arbitrary orientation in the image coordinate system 37.

The measurement field 42 is composed of at least one measurement line 43, preferably of a plurality of measurement lines 43 proceeding parallel to one

another, and each measurement line 43 comprises a plurality of pixels 36 whose position in the image coordinate system 37 is respectively defined by an image coordinate pair x_{VMP} and y_{VMP}, so that the position in the image coordinate system 37 can also be determined for each pixel 36 within the measurement lines 43. The longitudinal expanse of the measurement field 42 amounts to at least the same as the spacing of two engraving lines 21. The spacings of the pixels 36 from one another respectively represent a length increment. By counting the pixels 36 within a measurement distance 44, the length of the measurement distance 44 can thus be measured as a multiple of the length increment.

Figure 3 shows the formation of a stripe-shaped measurement field 42 that, for example, is composed of measurement lines 43 with fourteen pixels 36.

Figure 4 shows the formation of a quadratic measurement field 42 that, for example, is composed of 6 measurement lines 43 with respectively 6 pixels 36 in each measurement line 43.

As already explained, the edges of the cup area of a sample cup 19 in the registered video image 35 form a contour 45. The measurement distance 44, for example for measuring the maximum transverse diagonal or the maximum longitudinal diagonal of the sample cup 19, thus derives from the respective spacing of the corresponding contours 45 from one another.

The end pixels 36', 36" of the measurement distance 44 are advantageously determined with the assistance of the measurement field 42 itself on the basis of an automatic recognition of two neighboring contours 45, in that the respective video data VD of two successive pixels 36 of the measurement line 43 are investigated for a change of the video data VD.

Figure 5 shows the measurement band 42 with one measurement line 43 and two contours 45 spaced from one another. The video data VD allocated to the individual pixels 36 are also shown, whereby the contours 45 are characterized by the change "0' to "1" and "1" to "0". The corresponding end pixels 36', 36" of the

measurement distance 44, which is composed of 9 pixels 36 in the illustrated case, are determined by an automatic contour recognition.

Figure 6 shows the measurement of the image coordinate value x_{VB} of the measurement location 41 of the selected sample cup 19' with the stripe-shaped measurement field 42, which is composed of one measurement line 43. In the illustrated example, the measurement location 41 is the mid-point of the cup area of the selected sample cup 19'. The measurement field 42 has its longitudinal expanse aligned in the direction of the abscissa of the image coordinate system 37 and is shifted onto the selected sample cup 19'. The end pixels 36', 36" of the measurement distance 44 are determined by the automatic recognition of the contour 45 of the cup area of the selected sample cup 19'. The plurality of pixels 36 that devolve onto the measurement distance 44 is thus known, and the middle pixel 360 of the measurement distance 440 then represents the measurement location 41 of the selected sample cup 19'. The image coordinate value x_{VB} of the measurement location 41 of the selected sample cup 19' in the image coordinate system 37 then derives as a coordinate value of the middle pixel of the measurement distance 44.

Figure 7 shows the corresponding measurement of the image coordinate value y_{VB} of the measurement location 41 of the selected sample cup 19' with the measurement field 42 that has its longitudinal expanse aligned in the direction of the ordinate of the image coordinate system 37 for this purpose. In the illustrated example, the measurement location 41 is again the mid-point of the cup area. The image coordinate value y_{VB} of the measurement location 41 of the selected sample cup 19' then derives from the identified coordinate value of the middle pixel 36 of the measurement distance 44.

Advantageously, the selected sample cup 19' that represents a defined tone value is automatically "sought" in the video image 35 with the assistance of a measurement field 42 composed of a plurality of measurement lines 43. For that purpose, the cup area of the sample cup 19' is prescribed according to the predetermined tone value as a plurality of pixels 36. A corresponding measurement

field is shown in Figure 4. The size of the measurement field 42 at least corresponds to the size of the predetermined cup area, so that all pixels 36 falling into the cup area can be covered by the measurement field 42. The measurement field 42 is shifted across the video image 35 from engraving location to engraving location of the sample cups 19. At every engraving location, the cup area of the corresponding sample cup 19 is measured with the assistance of the measurement field 42 in that the pixels 36 counted in the individual measurement lines 43 are added up and compared to the pixel plurality of the predetermined cup area. A sample cup 19 has been identified as selected sample cup 19' when the predetermined and the measured cup area agree.

In a method step **[E]**, the measured position errors Δx_M and Δy_M are compensated by displacing the measurement carriage 23 and/or by turning the printing cylinder 1. The compensation can ensue manually under visual control of the video image on the control monitor 27 or with an automatic control of cylinder drive 2 and/or engraving carriage drive 7 via the controller 14. The image evaluation unit 23 thereby supplies a corresponding control command S_4 to the controller 14 via a line 33 when the evaluation of the video image has yielded that the measurement location 41 of the selected sample cup 19' is congruent with the coordinate origin 38 of the measurement coordinate system 40, as a result whereof an exact determination of the geometry values of the engraved sample cups 19 is assured.

Figure 8 shows the video image 35 after the correction of the position errors Δx_M and Δy_M. The measurement location 41 of the selected sample cup 19' is now congruent with the coordinate origin 38 of the measurement coordinate system 40 in the video image 35.

In most instances, it suffices to merely compensate the axial position error Δx_M by shifting the measurement carriage 23 since a plurality of sample cups 19 for a tone value are usually engraved in engraving line direction and, thus, at least one sample cup 19 of a tone value lies in the pickup area of the video camera 24.

After compensation of the position errors Δx_M and Δy_M, the determination of the geometry values of the engraved sample cups 19 occurs in a method step **[F]** with an automatic evaluation in the image evaluation unit 26 of the video image 35 according to Figure 8 registered with the video camera 24. The measurement is advantageously implemented with the assistance of the same measurement field 42 that was already employed for the measurement of the position errors Δx_M and Δy_M.

For measuring the maximum transverse diagonal d_{Qmax}, which corresponds to the measurement distance 44 in Figure 6, or an arbitrary transverse diagonal d_Q of a sample cup 19, the measurement field – as already shown in Figure 6 – has its longitudinal expanse aligned in the direction of the abscissa of the measurement coordinate system 40.

For measuring the maximum longitudinal diagonal d_{Lmax}, which corresponds to the measurement distance in Figure 7, or an arbitrary longitudinal diagonal d_L of a sample cup 19, the measurement field 42 – as shown in Figure 7 – has its longitudinal expanse aligned in the direction of the ordinate of the measurement coordinate system 40.

For measuring the pilot cut d_{DS}, i.e. the width of the engraving channel in the direction of the abscissa of the measurement coordinate system 40 that connects two sample cups 19 engraved on an engraving line 21, the measurement field 42 again has its longitudinal expanse aligned in the direction of the abscissa. The measurement of the pilot cut d_{DS} is graphically shown in Figure 9.

For measuring the web width d_{SB}, i.e. the width of the material that has remained standing between two deep cups engraved on neighboring engraving lines 21, 21', the measurement field is expediently turned such that it has its longitudinal expanse aligned approximately perpendicularly to the course of the web. The measurement of the web width d_{SB} is graphically shown in Figure 10.

Figure 11 schematically shows an electronic engraving machine for engraving printing forms with a second exemplary embodiment for a measuring device for measuring engraved sample cups 19.

In this exemplary embodiment, the video camera 24 – differing from what is shown in Figure 1 – is not arranged on a separate measurement carriage 23 but on the engraving carriage 7 next to the engraving element 3 with a structurally conditioned axial spacing B from the engraving stylus 4 of the engraving element 3. The video image 35 of the engraved sample cups 19 is picked up, for example, via a lightguide cable whose light entry face is arranged in a plane proceeding perpendicular to the axial direction and through the tip of the engraving stylus 4 of the engraving element 3. Alternatively thereto, the video image 35 of the engraved sample cups 19 can also be directly registered with the video camera 24. In this case, the video camera 24 mounted on the engraving carriage 5 is first shifted by the axial distance B onto the predetermined measurement position in the sample engraving region 20 with the engraving carriage drive 7 after engraving the sample cups 19. Subsequently, the position errors Δx_M and Δy_M are measured and corrected and the engraved sample cups 19 are measured.

Figure 12, in summary, schematically shows the work execution at an engraving machine, whereby it is assumed that the video camera 24 is mounted next to the engraving element 3 on the engraving carriage 5 according to the exemplary embodiment according to Figure 11.

a) Displacing the engraving element 3 with the engraving carriage 5 onto a predetermined, axial rated position 47 of an engraving line 21 to be engraved and engraving of sample cups 19 on an engraving line 21 in an axial actual position 48 that, due to an axial position error Δx, deviates from the rated position 47, according to method steps **[A]** and **[B]**.

b) Positioning the video camera 24 to the predetermined measurement position 47, which coincides with the predetermined rated position 47 of the engraving line 21, by displacing the engraving carriage 5 according to method step **[C]**.

c) Measuring the position error Δx of the video camera 24 in the predetermined measurement position 47 according to method step **[D]**.

d) Correction of the position error Δx of the video camera 24 by displacing the engraving carriage 5 into a new measurement position 48 according to method step **[E]** and

e) measuring the engraved sample cups 19 that were engraved on the engraving line 21 in the actual position 48 at the new measurement position 48 of the video camera 24 according to method step **[F]**.

The method can preferably also be utilized in the engraving of a plurality of engraving lanes lying juxtaposed in axial direction on a printing cylinder with a respectively allocated engraving element and in what is referred to as the twin mode of the engraving machine.

When engraving a plurality of engraving lanes on a printing cylinder 1 with a respectively allocated engraving element 3, a separate sample engraving must be implemented for each engraving element 3. For measuring the sample engravings, let the engraving machine be equipped with the displaceable measurement carriage 23 with the video camera 24 according to the exemplary embodiment of Figure 1. For measuring the individual sample engravings in each engraving lane, the video camera 24 is respectively axially displaced onto the individual measurement positions by the width of an engraving lane. In this case, the above-explained method steps **[A]** through **[F]** are implemented in every measurement position. Of course, a video camera according to the exemplary embodiment of Figure 11 can also be allocated to each engraving element 3.

In what is referred to as the twin mode of an engraving machine, two printing cylinders 1, 1* are mechanically coupled to one another, these being engraved with a respective engraving element 3, 3*. The engraving element 3, 3* are mounted on the shared engraving carriage 5 with a fixed spacing from one another, said engraving carriage 5 moving axially along both printing cylinders 1, 1*. A sampling

engraving is engraved on the appertaining printing cylinder 1, 1* with each engraving element 3, 3*. For measuring the sample engravings, let the engraving element 3, 3* comprise a video camera 24, 24* on the engraving carriage 5 next to each engraving element 3, 3* according to the exemplary embodiment of Figure 11. A modified work sequence derives in this case.

Figure 13 schematically shows the modified work sequence at an engraving machine working in twin mode, whereby it is assumed that a respective video camera 24, 24* is mounted on the shared engraving carriage 5 next to the engraving element 3, 3* according to the exemplary embodiment of Figure 11.

a) Displacing the engraving elements 3, 3* with the shared engraving carriage 5 onto predetermined, axial rated position 47, 47* of engraving lines 21, 21* to be engraved and engraving sample cups 19, 19* on the engraving lines 21, 21* in axial actual positions 48, 48* that deviate from the rated positions 47, 47* due to axial position errors Δx and Δx^*, according to method steps **[A]** and **[B]**.

b) Positioning the first video camera 24 to a predetermined, first measurement position 47 that coincides with the predetermined, first rated position 47 of an engraving line 21 by displacing the shared engraving carriage 5 according to method step **[C]**.

c) Measuring the position error Δx of the first video camera 24 in the predetermined, first measurement position 47 according to method step **[D]**.

d) Correcting the measured position error Δx of the first video camera 24 by displacing the shared engraving carriage 5 into a new first measurement position 48 according to method step **[E]**.

e) Measuring the geometry values of the sample cups 19 engraved on the first printing cylinder 1 that were engraved on the engraving line 21 in the first

actual position 48 at the new, first measurement position 50 of the first video camera 240 according to method step **[F]**.

f) Measuring the position error Δx^* of the second video camera 24* in the momentary position of the shared engraving carriage 5 according to method step **[D]**.

g) Calculating a new position error Δx^*_{new} for the second video camera 24*.

h) Correcting the calculated position error Δx^*_{new} of the second video camera 24* into a new, second measurement position 48* by displacing the shared engraving carriage 5 according to method step **[E]**, and

i) measuring the geometry values of the sample cups 19 engraved on the second printing cylinder 1* that were engraved on the engraving line 21* in the second actual position 48* at the new, second measurement position 50* of the second video camera 24* according to method step **[F]**.

Although only a preferred embodiment has been shown, other related embodiments may be suggested by those skilled in the art. Also, various minor modifications might be suggested by those skilled in the art, and it should be understood that it is my wish to embody within the scope of the patent warranted hereon all such other embodiments and modifications as reasonably and properly come within the scope of my contribution to the art.

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SPECIFICATION

TITLE

METHOD FOR GENERATING AND EVALUATING A SAMPLE ENGRAVING

BACKGROUND OF THE INVENTION

The invention is in the field of electronic reproduction technology and is directed to a method for generating and evaluating a sample engraving in an electronic engraving machine for engraving printing cylinders for rotogravure.

In an electronic engraving machine, an engraving element with an engraving stylus as **a** cutting tool moves in **an** axial direction along a rotating printing cylinder. The engraving stylus controlled by an engraving control signal cuts a sequence of cups arranged in an engraving ~~raster~~ **screen** into the generated surface of the printing cylinder. The engraving control signal is formed by superimposition of image signal values, which represent the ~~hues~~ **tone values** to be engraved between "light" ~~(white)~~ **white** and "dark" ~~(black)~~ **black**, with a periodic ~~raster~~ **screen** signal. Whereas the ~~raster~~ **screen** signal effects ~~an~~ **a** vibrating lifting motion of the engraving stylus for generating the engraving ~~raster~~ **screen**, the image signal values determine the geometry values of the cups engraved into the printing cylinder.

The engraving control signal must be calibrated so that the engraved ~~hues~~ **tone values** correspond to the hues defined by the image signal values. ~~To~~ **For** that ~~end~~ **purpose**, what is referred to as a sample engraving is implemented before the actual engraving, sample cups for predetermined ~~hues~~ **tone values** being engraved into the printing cylinder in this sample engraving.

After the sample engraving, a measuring instrument is positioned on the engraved sample cups and their geometry values such as, for example, the transverse diagonals and longitudinal diagonals are measured.

The measured geometry values of the sample cups are then compared to the predetermined geometry values. Setting values are obtained from the comparison with which the engraving control signal is calibrated such that the geometry values of

the cups generated in the later engraving coincide with the geometry values required for reproduction with proper ~~hues~~ **tone values**.

The PCT patent application serial number PCT/DE 98/01441 has already disclosed that a video camera with an image evaluation unit be employed for determining the geometry values of engraved sample cups, the geometry values in a video image of the sample cups registered with the video camera being measured with said image evaluation unit.

A prerequisite for an exact measurement is that the sample cups fall completely into the image excerpt registered by the video camera after a manual or automatic positioning of the video camera given optimum image resolution. This condition is not always met in practice, particularly after changing engraving styli, and mismeasurements are the result.

SUMMARY OF THE INVENTION

It is therefore an object of the present invention to improve a method for generating and evaluating a sample engraving in an electronic engraving machine for engraving printing cylinders for rotogravure with respect to the positioning of a measuring instrument, particularly a video camera, such that a high-precision, automatic measuring of the sample cups generated in the sample engraving is assured.

~~This object is achieved by the features of claim 1. Advantageous developments and improvements are recited in the subclaims.~~ **According to the method of the present invention for generating and evaluating a sample cut in an electronic engraving machine for engraving printing cylinders for rotogravure, an engraving control signal for driving an engraving stylus of an engraving element is formed from engraving data which represent tone values to be engraved between "light" and "dark" and a periodic screen signal for generating an engraving screen. With the engraving stylus, a sequence of cups arranged in the engraving screen is engraved into the printing cylinder engraving line by engraving line, geometry values of the cups determining the engraved tone**

values. Sample cups for predetermined tone values are engraved before actual engraving. A video camera is positioned to a predetermined, axial measurement position and with which a video image of the sample cups is registered. One of the engraved sample cups is selected. A positional deviation of a measurement location of the selected sample cup from a reference location in the video image is identified as a position error. The identified position error is corrected by at least one of axial displacement of the video camera into a new measurement position and by turning the printing cylinder such that the measurement location of the selected sample cup lies at least in a region of the reference location of the video image. Geometry values of at least the selected sample cup are subsequently measured and these geometry values are compared to geometry values of the predetermined tone values. The engraving control signal is calibrated dependent on a result of the comparison such that the engraved tone values correspond to the predetermined tone values.

The invention is explained in greater detail below on the basis of Figures 1 through 13.

~~Shown are:~~ **BRIEF DESCRIPTION OF THE DRAWINGS**

Figure 1 **shows schematically** an electronic engraving machine for engraving printing forms with a first exemplary embodiment for the arrangement of a measuring instruments for measuring engraved sample cups~~, shown schematically~~;

Figure 2 **is** a video image of engraved sample cups before correction of positioning errors of a video camera;

Figure 3 **shows** the formation of a stripe-shaped measuring field;

Figure 4 **shows** the formation of a quadratic measuring field;

Figure 5 **is** a graphic presentation for automatically determining a measuring distance within a measurement field;

Figure 6 **is** a graphic presentation for measuring the positioning errors of a sample cup in one coordinate direction;

Figure 7 **is** a graphic presentation for measuring the positioning errors of a sample cup in the other coordinate direction;

Figure 8 **is** a video image of engraved sample cups after a correction of positioning errors of a video camera;

Figure 9 **is** a graphic presentation for measuring a pilot cut;

Figure 10 **is** a graphic presentation for measuring a web width;\

Figure 11 **shows schematically** an electronic engraving machine for engraving printing forms with a second exemplary embodiment for the arrangement of a measuring instruments for measuring engraved sample cups~~, shown schematically~~;

Figure 12 **shows** the method sequence given an engraving machine; and

Figure 13 **shows** the method sequence given an engraving machine working in twin mode.

<u>DESCRIPTION OF THE PREFERRED EMBODIMENTS</u>

Figure 1 schematically shows an electronic engraving machine for engraving printing forms for rotogravure with a first exemplary embodiment for a measuring instrument for measuring sample cups generated in a sample engraving. For example, the engraving machine is a HelioKlischograph® of Hell Gravure Systems GmbH, Kiel, Germany.

A printing cylinder (10 is rotationally driven by a cylinder drive ~~(2)~~ **2**. The engraving on the printing cylinder ~~(1) ensues~~ **1 occurs** with an engraving element ~~(3)~~ **3** having an engraving stylus ~~(4)~~ **4** as cutting tool. The engraving element ~~(3)~~ **3** is located on an engraving carriage ~~(5)~~ **5** that can be moved in axial direction of the printing cylinder ~~(1)~~ **1** by an engraving carriage drive ~~(7)~~ **7** on the basis of a spindle ~~(6)~~ **6**.

The engraving stylus ~~(4)~~ **4** cuts a sequence of cups arranged in an engraving ~~raster~~ **screen** into the generated surface of the rotating printing cylinder ~~(1)~~

1 engraving line by engraving line while the engraving carriage ~~(5)~~ **5** with the engraving element ~~(3)~~ **3** moves along the printing cylinder ~~(1)~~ **1** in **the** axial direction.

The engraving stylus ~~(4)~~ **4** is controlled by an engraving control signal ~~(GS)~~ **GS**. The engraving control signal ~~(GS)~~ **GS** is formed in an engraving amplifier ~~(8)~~ **8** by superimposition of a periodic ~~raster~~ **screen** signal ~~(R)~~ **R** with image signal values ~~(B)~~ **B** that represent the ~~hues~~ **tone values** of the cups to be engraved between "light" and "dark". Whereas the periodic ~~raster~~ **screen** signal ~~(R)~~ **R** effects a vibrating lifting motion of the engraving stylus ~~(4)~~ **4** for generating the engraving ~~raster~~ **screen**, the image signal values ~~(B)~~ **B** corresponding to the ~~hues~~ **tone values** to be engraved determine the geometry values of the engraved cups.

The analog image signal values ~~(B)~~ **B** are acquired in a D/A converter ~~(9)~~ **9** from engraving data ~~(GD)~~ **GD** that are deposited in an engraving data memory ~~(10)~~ **10** and read therefrom engraving line by engraving line and supplied to the D/A converter ~~(9)~~ **9**. Each engraving location in the engraving ~~raster~~ **screen** has an engraving datum ~~(GD)~~ **GD** of at least one byte allocated to it that, as engraving information, contains the ~~hue~~ **tone value tone value** between "light" and "dark" to be engraved.

The generated surface of the printing cylinder ~~(1)~~ **1** has an engraving coordinate system allocated to it whose abscissa axis ~~ir~~ **is** oriented in axial direction of the printing cylinder ~~(1)~~ **1** (feed direction of the engraving element) and whose ordinate axis is oriented in circumferential direction of the printing cylinder ~~(1)~~ **1** (direction of the engraving lines). The engraving coordinates x_G and y_G of the engraving coordinate system define the engraving locations for the cups on the printing cylinder ~~(1)~~ **1**. The engraving carriage drive ~~(7)~~ **7** generates the engraving coordinates x_G that determine the axial positions of the engraving lines on the printing cylinder ~~(1)~~ **1**. A position sensor ~~(11)~~ **11** mechanically coupled to the cylinder drive ~~(2)~~ **2** generates the corresponding engraving coordinates y_G that indicate the relative circumferential positions of the rotating printing cylinder ~~(1)~~ **1** relative to the

engraving stylus ~~(4)~~ **4**. The engraving coordinates x_G and y_G of the engraving locations are supplied to a controller ~~(14)~~ **14** via lines ~~(12, 13)~~ **12, 13**.

The controller ~~(14)~~ **14** controls the addressing and the readout of the engraving data ~~(GD)~~ **GD** from the engraving data memory ~~(10)~~ **10** dependent on the engraving coordinates x_G and y_G of the current engraving locations via a line ~~(15).~~ **15.** The controller ~~(14)~~ **14** also generates the ~~raster~~ **screen** signal ~~(R)~~ **R** on a line ~~(16)~~ 16 with the frequency required for generating the engraving ~~raster~~ **screen**. For axial positioning of the engraving element ~~(3)~~ **3** relative to the printing cylinder ~~(1)~~ **1** and for controlling the feed motion of the engraving element ~~(3)~~ **3** during engraving, corresponding control commands ~~(S1)~~ **S_1** on a line ~~(17)~~ **17** to the engraving carriage drive ~~(7)~~ **7** are generated in the controller ~~(14)~~ **14**. Further control commands ~~(S2)~~ S_2 on a line ~~(18)~~ **18** control the cylinder drive ~~(2)~~ **2**.

For engraving sample cups ~~(19)~~ **19** on juxtaposed engraving lines ~~(21)~~ **21** in a sample engraving region ~~(20)~~ **20** of the printing cylinder ~~(1)~~ **1** that is not used for the later engraving, the engraving machine comprises a sample engraving computer ~~(22)~~ **22** that supplies the required engraving data ~~(GD*)~~ **GD*** to the D/A converter ~~(9)~~ **9.**

For measuring the geometry values of the sample cups ~~(19)~~ **19** generated in the sample engraving, a measuring carriage ~~(23)~~ **23** displaceable in **the** axial direction of the printing cylinder ~~(1)~~ **1** and having a video camera ~~(24)~~ **24** for recording a video image of the sample cups ~~(19)~~ **19**, an image evaluation unit ~~(26)~~ **26** connected to the video camera ~~(24)~~ **24** via a line ~~(25)~~ **25** for measuring the registered sample cups ~~(19)~~ **19** and a control monitor ~~(27)~~ **27** for monitoring the video image are present in the first exemplary embodiment shown in Figure 1.

The geometry values of the sample cups to be measured can, for example, be the transverse diagonals, the longitudinal diagonals, the widths of the pilot cuts and the web widths.

The video image of the sample cups ~~(19)~~ **19** can be made given a stationary printing cylinder ~~(1)~~ **1** or during the rotation of the printing cylinder ~~(1)~~ **1**, given a corresponding synchronization. The measuring carriage ~~(23)~~ **23** with the video camera ~~(24)~~ **24** can be axially positioned onto the sample cups ~~(19)~~ **19** generated in the sample engraving region, being positioned with a spindle ~~(28)~~ **28** and a measuring carriage drive ~~(29)~~ **29**. The measuring carriage drive ~~(29)~~ **29** is controlled by the controller ~~(1~~40 by control commands ~~(S3)~~ **S_3** on a line ~~(30)~~ **30**.

The geometry values of the sample cups ~~(19)~~ **19** measured in the image evaluation unit ~~(26)~~ **26** on the basis of the video image are transmitted to the sample engraving computer ~~(22)~~ **22** via a line ~~(31)~~ **31**. Setting values for calibrating the engraving amplifier ~~(8)~~ **8** are acquired in the sample engraving computer ~~(22)~~ **22** by comparing the measured, actual geometry values to the predetermined, rated geometry values. The engraving control signal ~~(GS)~~ **GS** in the engraving amplifier ~~(8)~~ **8** is then calibrated ~~such~~ with the setting values, which are supplied to the engraving amplifier ~~(8)~~ **8** via a line ~~(32),~~ **32, such** that the cups actually generated in the later engraving of the printing cylinder ~~(1)~~ **1** correspond to the cups required for an engraving with correct ~~hues~~ **tone values.**

The calibration of the engraving control signal ~~(GS)~~ **GS** can ~~ensue~~ **occur** automatically before the engraving or online during the engraving. The calibration, however, can also be manually implemented in that the sample engraving computer ~~(22)~~ **22** merely displays the setting values that have been determined, these then being manually transferred to the engraving amplifier ~~(8)~~ **8**.

The generation and evaluation of a sample engraving sequences according to the following method steps:

In a method step **[A]** for the implementation of the sample engraving, the engraving element ~~(3)~~ **3** with the engraving carriage ~~(5)~~ **5** is axially displaced from a zero position onto a rated position at which the first engraving line ~~(21')~~ **21'** is to be engraved within the sample engraving region ~~(20)~~ **20** provided for the sample

engraving, being manually or automatically displaced with the engraving carriage drive ~~(7)~~ **7**.

In a method step **[B]**, the sample engraving computer ~~(22)~~ **22** calls, for example, the engraving data ~~(GD*)~~ **GD*** for the rated ~~hues~~ **tone values** "dark", "light" and for at least one "mid-~~hue~~ **tone value**" between "light" and "dark" for engraving the sample cups ~~(19)~~ **19**. The engraving data ~~(GD*)~~ **GD*** that have been called are converted into the engraving control signal ~~(GS)~~ **GS** for the engraving element ~~(3)~~ **3**. Proceeding from the first engraving line ~~(21')~~ **21'**, the engraving element ~~(3)~~ **3** respectively engraves at least one sample cup ~~(19)~~ **19** for "light", "dark" and "mid-~~hue~~ **tone value**" on juxtaposed engraving lines ~~(21)~~ **21**. A plurality of sample cups ~~(19)~~ **19** of the same ~~hue~~ **tone value** are preferably engraved in circumferential direction on each engraving line ~~(21, 21')~~ **21, 21'** within the expanse of the sample engraving region ~~(20)~~ **20**.

In a method step **[C]**, the video camera ~~(24)~~ **24** with the measuring carriage ~~(23)~~ **23** is manually or automatically displaced with the measuring carriage drive ~~(29)~~ **29** from a zero position onto a predetermined measuring position that corresponds to the rated position of that engraving line ~~(21)~~ **21** whose sample cups ~~(19)~~ **19** are to be measured, for example onto the rated position of the first engraving line ~~(21')~~ **21'**, being displaced for measuring the geometry values of the engraved sample cups ~~(19)~~ **19**.

Let the video camera ~~(24)~~ **24** be adjusted such that, given coincidence of **the** measuring position and **the** rated position of an engraving line ~~(21)~~ **21**, the sample cups ~~(19)~~ **19** of this engraving line to be measured lie on a reference location in the middle of the video image, for example on the ordinate axis of a measurement coordinate system with the coordinate origin in the middle of the image. It is thereby assured that the sample cups ~~(19)~~ **19** are fully covered by the video camera ~~(24)~~ **24** given optimum image resolution in order to achieve a high measuring precision.

In practice, however, the engraving stylus ~~(4)~~ **4** must be occasionally replaced. Without involved readjustment, the original engraving stylus position can be lost when changing engraving styli, and the sample cups ~~(19)~~ **19** are engraved at engraving locations that deviate from the rated engraving locations defined by the engraving coordinate values x_G and y_G. In this case, the sample cups ~~(19)~~ **19** are engraved on engraving lines ~~(21, 21')~~ **21, 21'** whose axial actual positions are offset compared to the predetermined rated positions. Given displacement of the video camera ~~(24)~~ **24** onto a predetermined measuring position that coincides with a predetermined rated position of an engraving line ~~(21, 21')~~ **21, 21'**, positive and negative position errors Δx_M and Δy_M of the sample cups ~~(19)~~ **19** engraved on the offset engraving line ~~(21, 21')~~ **21, 21'** compared to the measurement coordinate system therefore appear in the video image. Due to these position errors Δx_M and Δy_M, it can therefore occur that the sample cups ~~(19)~~ **19** do not fully lie in the video image given optimum image resolution, and imprecisions in the measurement of the geometry values of the sample cups are the result.

In order to improve the measuring precision, it is therefore proposed that one of the engraved sample cups ~~(19)~~ **19** be selected, the position errors Δx_M and Δy_M of the selected sample cup ~~be~~ **being** measured in a method step **[D]** as coordinate-related distances of a measuring location of the sample cup from a reference location in the video image, for example relative to the coordinate origin of the measurement coordinate system, and the identified position errors Δx_M and Δy_M ~~be~~ **are** corrected ~~such~~ before measuring the geometry values of at least the selected sample cup in a method step **[E]** by displacing the video camera ~~(24)~~ **24** onto a new measuring position and/or by turning the printing cylinder ~~(1)~~ **1 such** that the measuring location of the selected sample cup ~~(19')~~ **19'** lies in the reference location of the video image.

In the method step **[D]**, the position errors Δx_M and Δy_M of the measuring location of the selected sample cup ~~(19')~~ **19'** that have arisen in the positioning of the

video camera ~~(24)~~ **24** to a predetermined measuring position are first measured relative to the coordinate origin of the measurement coordinate system in the image evaluation unit ~~(26)~~ **26** on the basis of the registered video image.

For example, a sample cup ~~(19)~~ **19** that represents a "mid-~~hue" (M)~~ **tone value" M** or, on the other hand, some other sample cup ~~(19)~~ **19** as well should therefore be selected as sample cup ~~(19')~~ **19'** whose measuring location is to be shifted into the coordinate origin of the measurement coordinate system. Dependent on which geometry values are to be determined, the mid-point of the cup area, the mid-point of the transverse diagonals or longitudinal diagonals of the sample cup or, on the other hand, the mid-point of a web or pilot cut to be measured should be defined as **a** measuring location of the selected sample cup ~~(19')~~ **19'**. The measurement of the position errors Δx_M and Δy_M of the selected sample cup in the video image is explained on the basis of Figure 2.

Figure 2 shows a registered video image ~~(35)~~ **35** of the engraved sample cups ~~(19)~~ **19** with the orthogonal engraving ~~raster~~ **screen** composed of horizontal and vertical ~~raster~~ **screen** lines, whereby the vertical ~~raster~~ **screen** lines are the engraving lines ~~(21)~~ **21**. For example, engraved sample cups ~~(19)~~ **19** for "light" ~~(L)~~ **L**, "dark" ~~(T)~~ **T** and "mid-~~hue" (M)~~ **tone value" M** are shown on three juxtaposed engraving lines ~~(21)~~ **21**. The centers of gravity of the sample cups ~~(19)~~ **19** lie on the intersections of the ~~raster~~ **screen** lines of the engraving ~~raster~~ **screen**.

The video image ~~(35)~~ **35** is composed of a plurality of pixels ~~(36)~~ **36** whose positions in the video image ~~(35)~~ **35** are defined by the image coordinates x_V and y_V of an image coordinate system ~~(37)~~ **37** allocated to the video image ~~(35)~~ **35**. The coordinate axes of the image coordinate system ~~(37)~~ **37** is directed in **the** longitudinal and **the** transverse expanse of the video image ~~(35)~~ **35**, and the coordinate origin ~~(36)~~ **36** lies in a corner point of the video image ~~(35)~~ **35**. The coordinate axes of the measurement coordinate system ~~(4)~~ **4** are aligned parallel to the coordinate axes of the image coordinate system ~~(37)~~ **37**. The coordinate origin ~~(39)~~

39 of the measurement coordinate system ~~(40)~~ **40**, which lies in the mid-point of the video image ~~(35)~~ **35** has the image coordinates x_{VM} and y_{VM} in the image coordinate system ~~(37)~~ **37**. The following coordinate-related relationship thus derives:

$$x_M = x_V - x_{VM}$$
$$y_M = y_V - y_{VM}$$

For example, the sample cup ~~(19')~~ **19'** with the mid-point of the cup area as measuring location ~~(41)~~ **41** that has the image coordinates x_{VB} and y_{VB} in the image coordinate system ~~(37)~~ **37** is selected. The position errors Δx_M and Δy_M of the selected sample cup ~~(19')~~ **19'** in the measurement coordinate system ~~(40)~~ **40** thus derive as:

$$\Delta x_M = x_{VB} - x_{VM}$$
$$\Delta y_M = y_{VB} - y_{VM}$$

Every pixel ~~(36)~~ **36** has a video datum ~~(VD)~~ **VD** of, for example, 8 bits characterizing the respective gray scale value allocated to it, so that a total of 254 gray scale values can be distinguished between "black" ~~(VD=0)~~ **VD=0** and "white" ~~(VD=255)~~ **VD=255**. By filtering or with thresholds, the gray scale values can be reduced such to two values that, for example, the video datum VD = 0 is allocated to those pixels that fall onto the generated surface of the printing cylinder ~~(1)~~ **1** and the video datum VD = 1 is allocated to those pixels that fall onto the cup areas of the sample cup ~~(19)~~ **19**. The contour (density discontinuity) of a cup area is thereby characterized by the change of the video datum from "0" to "1" or from "1" to "0".

For automatically determining the image coordinate values x_{VB} and y_{VB} of the measuring location ~~(41)~~ **41** of the selected sample cup ~~(19')~~ **19'** in the image coordinate system ~~(37),~~ **37,** for example~~,~~ a stripe-shaped measurement field ~~(42)~~ **42** is defined that can be shifted across the video image and that can be aligned with an arbitrary orientation in the image coordinate system ~~(37)~~ **37**.

The measurement field ~~(42)~~ **42** is composed of at least one measurement line ~~(43)~~ **43**, preferably of a plurality of measurement lines ~~(43)~~ **43** proceeding parallel to one another, and each measurement line ~~(43)~~ **43** comprises a plurality of pixels ~~(36)~~

36 whose position in the image coordinate system ~~(37)~~ **37** is respectively defined by an image coordinate pair x_{VMP} and y_{VMP}, so that the position in the image coordinate system ~~(37)~~ **37** can also be determined for each pixel ~~(36)~~ **36** within the measurement lines ~~(43)~~ **43**. The longitudinal expanse of the measurement field ~~(42)~~ **42** amounts to at least the same as the spacing of two engraving lines ~~(21)~~ **21**. The spacings of the pixels ~~(36)~~ **36** from one another respectively represent a length increment. By counting the pixels ~~(36)~~ **36** within a measurement distance ~~(44)~~ **44**, the length of the measurement distance ~~(44)~~ **44** can thus be measured as a multiple of the length increment.

Figure 3 shows the formation of a stripe-shaped measurement field ~~(42)~~ **42** that, for example, is composed of ~~a~~ measurement lines ~~[sic] (43)~~ **43** with fourteen pixels ~~(36)~~ **36**.

Figure 4 shows the formation of a quadratic measurement field ~~(42)~~ **42** that, for example, is composed of 6 measurement lines ~~(43)~~ **43** with respectively 6 pixels ~~(36)~~ **36** in each measurement line ~~(43)~~ **43**.

As already explained, the edges of the cup area of a sample cup ~~(19)~~ **19** in the registered video image ~~(35)~~ **35** form a contour ~~(45)~~ **45**. The measurement distance ~~(44)~~ **44**, for example for measuring the maximum transverse diagonal or the maximum longitudinal diagonal of the sample cup ~~(19)~~ **19**, thus derives from the respective spacing of the corresponding contours ~~(45)~~ **45** from one another.

The end pixels ~~(36', 36")~~ **36', 36"** of the measurement distance ~~(44)~~ **44** are advantageously determined with the assistance of the measurement field ~~(42)~~ **42** itself on the basis of an automatic recognition of two neighboring contours ~~(45)~~ **45**, in that the respective video data ~~(VD)~~ **VD** of two successive pixels ~~(36)~~ **36** of the measurement line ~~(43)~~ **43** are investigated for a change of the video data ~~(VD)~~ **VD**.

Figure 5 shows the measurement band ~~(42)~~ **42** with one measurement line ~~(43)~~ **43** and two contours ~~(45)~~ **45** spaced from one another. The video data ~~(VD)~~ **VD** allocated to the individual pixels ~~(36)~~ **36** are also shown, whereby the contours ~~(45)~~

45 are characterized by the change "0' to "1" and "1" to "0". The corresponding end pixels ~~(36', 36")~~ **36', 36"** of the measurement distance ~~(44)~~ **44**, which is composed of 9 pixels ~~(36)~~ **36** in the illustrated case, are determined by an automatic contour recognition.

Figure 6 shows the measurement of the image coordinate value x_{VB} of the measurement location ~~(41)~~ **41** of the selected sample cup ~~(19')~~ **19'** with the stripe-shaped measurement field ~~(42)~~ **42**, which is composed of one measurement line ~~(43)~~ **43**. In the illustrated example, the measurement location ~~(41)~~ **41** is the mid-point of the cup area of the selected sample cup ~~(19')~~ **19'**. The measurement field ~~(42)~~ **42** has its longitudinal expanse aligned in the direction of the abscissa of the image coordinate system ~~(37)~~ **37** and is shifted onto the selected sample cup ~~(19')~~ **19'**. The end pixels ~~(36', 36")~~ **36', 36"** of the measurement distance ~~(44)~~ **44** are determined by the automatic recognition of the contour ~~(45)~~ **45** of the cup area of the selected sample cup ~~(19')~~ **19'**. The plurality of pixels ~~(36)~~ **36** that devolve onto the measurement distance ~~(44)~~ **44** is thus known, and the middle pixel (360 of the measurement distance (440 then represents the measurement location ~~(41)~~ **41** of the selected sample cup ~~(19')~~ **19'**. The image coordinate value x_{VB} of the measurement location ~~(41)~~ **41** of the selected sample cup ~~(19')~~ **19'** in the image coordinate system ~~(37)~~ **37** then derives as **a** coordinate value of the middle pixel of the measurement distance ~~(44)~~ **44**.

Figure 7 shows the corresponding measurement of the image coordinate value y_{VB} of the measurement location ~~(41)~~ **41** of the selected sample cup ~~(19')~~ **19'** with the measurement field ~~(42)~~ **42** that has its longitudinal expanse aligned in the direction of the ordinate of the image coordinate system ~~(37)~~ **37** for this purpose. In the illustrated example, the measurement location ~~(41)~~ **41** is again the mid-point of the cup area. The image coordinate value y_{VB} of the measurement location ~~(41)~~ **41** of the selected sample cup ~~(19')~~ **19'** then derives from the identified coordinate value of the middle pixel ~~(36)~~ **36** of the measurement distance ~~(44)~~ **44**.

Advantageously, the selected sample cup ~~(19')~~ **19'** that represents a defined ~~hue~~ **tone value** is automatically "sought" in the video image ~~(35)~~ **35** with the assistance of a measurement field ~~(42)~~ **42** composed of a plurality of measurement lines ~~(43). To~~ **43. For** that ~~end~~ **purpose**, the cup area of the sample cup ~~(19')~~ **19'** is prescribed according to the predetermined ~~hue~~ **tone value** as a plurality of pixels ~~(36)~~ **36**. A corresponding measurement field is shown in Figure 4. The size of the measurement field ~~(42)~~ **42** at least corresponds to the size of the predetermined cup area, so that all pixels ~~(36)~~ **36** falling into the cup area can be covered by the measurement field ~~(42)~~ **42**. The measurement field ~~(42)~~ **42** is shifted across the video image ~~(35)~~ **35** from engraving location to engraving location of the sample cups ~~(19)~~ **19**. At every engraving location, the cup area of the ~~appertaining~~ **corresponding** sample cup ~~(19)~~ **19** is measured with the assistance of the measurement field ~~(42)~~ **42** in that the pixels ~~(36)~~ **36** counted in the individual measurement lines ~~(43)~~ **43** are added up and compared to the pixel plurality of the predetermined cup area. A sample cup ~~(19)~~ **19** has been identified as selected sample cup ~~(19')~~ **19'** when the predetermined and the measured cup area agree.

In a method step **[E]**, the measured position errors Δx_M and Δy_M are compensated by displacing the measurement carriage ~~(23)~~ **23** and/or by turning the printing cylinder ~~(1)~~ **1**. The compensation can ensue manually under visual control of the video image on the control monitor ~~(27)~~ **27** or with an automatic control of cylinder drive ~~(2)~~ **2** and/or engraving carriage drive ~~(7)~~ **7** via the controller ~~(14)~~ **14**. The image evaluation unit ~~(23)~~ **23** thereby supplies a corresponding control command ~~(S4)~~ S_4 to the controller ~~(14)~~ **14** via a line ~~(33)~~ **33** when the evaluation of the video image has yielded that the measurement location ~~(41)~~ **41** of the selected sample cup ~~(19')~~ **19'** is congruent with the coordinate origin ~~(38)~~ **38** of the measurement coordinate system ~~(40)~~ **40**, as a result whereof an exact determination of the geometry values of the engraved sample cups ~~(19)~~ **19** is assured.

Figure 8 shows the video image ~~(35)~~ **35** after the correction of the position errors Δx_M and Δy_M. The measurement location ~~(41)~~ **41** of the selected sample cup ~~(19')~~ **19'** is now congruent with the coordinate origin ~~(38)~~ **38** of the measurement coordinate system ~~(40)~~ **40** in the video image ~~(35)~~ **35**.

In most instances, it suffices to merely compensate the axial position error Δx_M by shifting the measurement carriage ~~(23)~~ **23** since a plurality of sample cups ~~(19)~~ **19** for a ~~hue~~ **tone value** are usually engraved in engraving line direction and, thus, at least one sample cup ~~(19)~~ **19** of a ~~hue~~ **tone value** lies in the pickup area of the video camera ~~(24)~~ **24**.

After compensation of the position errors Δx_M and Δy_M, the determination of the geometry values of the engraved sample cups ~~(19) ensues~~ **19 occurs** in a method step **[F]** with an automatic evaluation in the image evaluation unit ~~(26)~~ **26** of the video image ~~(35)~~ **35** according to Figure 8 registered with the video camera ~~(24)~~ **24**. The measurement is advantageously implemented with the assistance of the same measurement field ~~(42)~~ **42** that was already employed for the measurement of the position errors Δx_M and Δy_M.

For measuring the maximum transverse diagonal ~~(dQmax)~~ $\mathbf{d_{Qmax}}$, which corresponds to the measurement distance ~~(44)~~ **44** in Figure 6, or an arbitrary transverse diagonal ~~(dQ)~~ $\mathbf{d_Q}$ of a sample cup ~~(19)~~ **19**, the measurement field – as already shown in Figure 6 – has its longitudinal expanse aligned in the direction of the abscissa of the measurement coordinate system ~~(40)~~ **40**.

For measuring the maximum longitudinal diagonal ~~(dLmax)~~ $\mathbf{d_{Lmax}}$, which corresponds to the measurement distance in Figure 7, or an arbitrary longitudinal diagonal ~~(dL)~~ $\mathbf{d_L}$ of a sample cup ~~(19)~~ **19**, the measurement field ~~(42)~~ **42** – as shown in Figure 7 – has its longitudinal expanse aligned in the direction of the ordinate of the measurement coordinate system ~~(40)~~ **40**.

For measuring the pilot cut ~~(dDS)~~ $\mathbf{d_{DS}}$, i.e. the width of the engraving channel in the direction of the abscissa of the measurement coordinate system ~~(40)~~ 40

that connects two sample cups ~~(19)~~ **19** engraved on an engraving line ~~(21)~~ **21**, the measurement field ~~(42)~~ **42** again has its longitudinal expanse aligned in the direction of the abscissa. The measurement of the pilot cut ~~(dDS)~~ $\mathbf{d_{DS}}$ is graphically shown in Figure 9.

For measuring the web width ~~(dSB)~~ $\mathbf{d_{SB}}$, i.e. the width of the material that has remained standing between two deep cups engraved on neighboring engraving lines ~~(21, 21')~~ **21, 21'**, the measurement field is expediently turned such that it has its longitudinal expanse aligned approximately perpendicularly to the course of the web. The measurement of the web width ~~(dSB)~~ $\mathbf{d_{SB}}$ is graphically shown in Figure 10.

Figure 11 schematically shows an electronic engraving machine for engraving printing forms with a second exemplary embodiment for a measuring device for measuring engraved sample cups ~~(19)~~ **19**.

In this exemplary embodiment, the video camera ~~(24)~~ **24** – differing from what is shown in Figure 1 – is not arranged on a separate measurement carriage ~~(23)~~ **23** but on the engraving carriage ~~(7)~~ **7** next to the engraving element ~~(3)~~ **3** with a structurally conditioned axial spacing B from the engraving stylus ~~(4)~~ **4** of the engraving element ~~(3)~~ **3**. The video image ~~(35)~~ **35** of the engraved sample cups ~~(19)~~ **19** is picked up, for example, via a lightguide cable whose light entry face is arranged in a plane proceeding perpendicular to the axial direction and through the tip of the engraving stylus ~~(4)~~ **4** of the engraving element ~~(3)~~ **3**. Alternatively thereto, the video image ~~(35)~~ **35** of the engraved sample cups ~~(19)~~ **19** can also be directly registered with the video camera ~~(24)~~ **24**. In this case, the video camera ~~(24)~~ **24** mounted on the engraving carriage ~~(5)~~ **5** is first shifted by the axial distance B onto the predetermined measurement position in the sample engraving region ~~(20)~~ **20** with the engraving carriage drive ~~(7)~~ **7** after engraving the sample cups ~~(19)~~ **19**. Subsequently, the position errors Δx_M and Δy_M are measured and corrected and the engraved sample cups ~~(19)~~ **19** are measured.

Figure 12, in summary, schematically shows the work execution at an engraving machine, whereby it is assumed that the video camera ~~(24)~~ **24** is mounted next to the engraving element ~~(3)~~ **3** on the engraving carriage ~~(5)~~ **5** according to the exemplary embodiment according to Figure 11.

a) Displacing the engraving element ~~(3)~~ **3** with the engraving carriage ~~(5)~~ **5** onto a predetermined, axial rated position ~~(47)~~ **47** of an engraving line ~~(21)~~ **21** to be engraved and engraving of sample cups ~~(19)~~ **19** on an engraving line ~~(21)~~ **21** in an axial actual position ~~(48)~~ **48** that, due to an axial position error Δx, deviates from the rated position ~~(47)~~ **47**, according to method steps **[A]** and **[B]**.

b) Positioning the video camera ~~(24)~~ **24** to the predetermined measurement position ~~(47)~~ **47**, which coincides with the predetermined rated position ~~(47)~~ **47** of the engraving line ~~(21)~~ **21**, by displacing the engraving carriage ~~(5)~~ **5** according to method step **[C]**.

c) Measuring the position error Δx of the video camera ~~(24)~~ **24** in the predetermined measurement position ~~(47)~~ **47** according to method step **[D]**.

d) Correction of the position error Δx of the video camera ~~(24)~~ **24** by displacing the engraving carriage ~~(5)~~ **5** into a new measurement position ~~(48)~~ **48** according to method step **[E]** and

e) measuring the engraved sample cups ~~(19)~~ **19** that were engraved on the engraving line ~~(21)~~ **21** in the actual position ~~(48)~~ **48** at the new measurement position ~~(48)~~ **48** of the video camera ~~(24)~~ **24** according to method step **[F]**.

The method can preferably also be utilized in the engraving of a plurality of engraving lanes lying juxtaposed in axial direction on a printing cylinder with a

respectively allocated engraving element and in what is referred to as the twin mode of the engraving machine.

When engraving a plurality of engraving lanes on a printing cylinder ~~(1)~~ **1** with a respectively allocated engraving element ~~(3)~~ **3**, a separate sample engraving must be implemented for each engraving element ~~(3)~~ **3**. For measuring the sample engravings, let the engraving machine be equipped with the displaceable measurement carriage ~~(23)~~ **23** with the video camera ~~(24)~~ **24** according to the exemplary embodiment of Figure 1. For measuring the individual sample engravings in each engraving lane, the video camera ~~(24)~~ **24** is respectively axially displaced onto the individual measurement positions by the width of an engraving lane. In this case, the above-explained method steps **[A]** through **[F]** are implemented in every measurement position. Of course, a video camera according to the exemplary embodiment of Figure 11 can also be allocated to each engraving element ~~(3)~~ **3**.

In what is referred to as the twin mode of an engraving machine, two printing cylinders ~~(~~1, 1*~~)~~ are mechanically coupled to one another, these being engraved with a respective engraving element ~~(~~3, 3*~~)~~. The engraving element ~~(~~3, 3*~~)~~ are mounted on the shared engraving carriage ~~(5)~~ **5** with a fixed spacing from one another, said engraving carriage ~~(5)~~ **5** moving axially along both printing cylinders ~~(~~1, 1*~~)~~. A sampling engraving is engraved on the appertaining printing cylinder ~~(~~1, 1*~~)~~ with each engraving element ~~(~~3, 3*~~)~~. For measuring the sample engravings, let the engraving element ~~(~~3, 3*~~)~~ comprise a video camera ~~(~~24, 24*~~)~~ on the engraving carriage ~~(5)~~ **5** next to each engraving element ~~(~~3, 3*~~)~~ according to the exemplary embodiment of Figure 11. A modified work sequence derives in this case.

Figure 13 schematically shows the modified work sequence at an engraving machine working in twin mode, whereby it is assumed that a respective video camera ~~(~~24, 24*~~)~~ is mounted on the shared engraving carriage ~~(5)~~ **5** next to the engraving element ~~(~~3, 3*~~)~~ according to the exemplary embodiment of Figure 11.

a) Displacing the engraving elements ~~(~~3, 3* ~~)~~ with the shared engraving carriage ~~(5)~~ **5** onto predetermined, axial rated position ~~(~~47, 47* ~~)~~ of engraving lines ~~(~~21, 21* ~~)~~ to be engraved and engraving sample cups ~~(~~19, 19* ~~)~~ on the engraving lines ~~(~~21, 21* ~~)~~ in axial actual positions ~~(~~48, 48* ~~)~~ that deviate from the rated positions ~~(~~47, 47* ~~)~~ due to axial position errors Δx and Δx^*, according to method steps **[A]** and **[B]**.

b) Positioning the first video camera ~~(24)~~ **24** to a predetermined, first measurement position ~~(47)~~ **47** that coincides with the predetermined, first rated position ~~(47)~~ **47** of an engraving line ~~(21)~~ **21** by displacing the shared engraving carriage ~~(5)~~ **5** according to method step **[C]**.

c) Measuring the position error Δx of the first video camera ~~(24)~~ **24** in the predetermined, first measurement position ~~(47)~~ **47** according to method step **[D]**.

d) Correcting the measured position error Δx of the first video camera ~~(24)~~ **24** by displacing the shared engraving carriage ~~(5)~~ **5** into a new first measurement position ~~(48)~~ **48** according to method step **[E]**.

e) Measuring the geometry values of the sample cups ~~(19)~~ **19** engraved on the first printing cylinder ~~(1)~~ **1** that were engraved on the engraving line ~~(21)~~ **21** in the first actual position ~~(48)~~ **48** at the new, first measurement position ~~(50)~~ **50** of the first video camera ~~(~~240 according to method step **[F]**.

f) Measuring the position error Δx^* of the second video camera ~~(24*)~~ **24*** in the momentary position of the shared engraving carriage ~~(5)~~ **5** according to method step **[D]**.

g) Calculating a new position error Δx^*_{new} for the second video camera ~~(24*)~~ **24***.

h) Correcting the calculated position error Δx^*_{new} of the second video camera ~~(24*)~~ **24*** into a new, second measurement position ~~(48*)~~ **48*** by

displacing the shared engraving carriage ~~(5)~~ **5** according to method step **[E]**, and

i) measuring the geometry values of the sample cups ~~(19)~~ **19** engraved on the second printing cylinder ~~(1*)~~ **1*** that were engraved on the engraving line ~~(21*)~~ **21*** in the second actual position ~~(48*)~~ **48*** at the new, second measurement position ~~(50*)~~ **50*** of the second video camera ~~(24*)~~ **24*** according to method step **[F]**.

Although only a preferred embodiment has been shown, other related embodiments may be suggested by those skilled in the art. Also, various minor modifications might be suggested by those skilled in the art, and it should be understood that it is my wish to embody within the scope of the patent warranted hereon all such other embodiments and modifications as reasonably and properly come within the scope of my contribution to the art.

09/744581

500 Rec'd PCT/PTO 25 JAN 2001

BOX PCT

IN THE UNITED STATES ELECTED OFFICE

OF THE UNITED STATES PATENT AND TRADEMARK OFFICE

UNDER THE PATENT COOPERATION TREATY-CHAPTER II

DRAWING CORRECTION LETTER

APPLICANT: ERNST-RUDOLF GOTTFRIED WEIDLICH

DOCKET NO: P00,1911

SERIAL NO: GROUP ART UNIT:

EXAMINER:

INTERNATIONAL APPLICATION NO: PCT/DE99/02175

INTERNATIONAL FILING DATE: 14 July 1999

INVENTION: **"METHOD FOR GENERATING AND EVALUATING A SAMPLE ENGRAVING"**

Assistant Commissioner for Patents
Washington, D.C. 20231

Sir:

Please amend Figs. 1, 11, 12 and 13 as indicated in red on the attached drawing copies.

Respectfully submitted,

Brett A Valiquet (Reg.No. 27,841)

Brett A. Valiquet
Schiff Hardin & Waite
Patent Application
71st Sears Tower
Chicago, Illinois 60606
(312) 258-5786
Attorneys for Applicant

09/744581

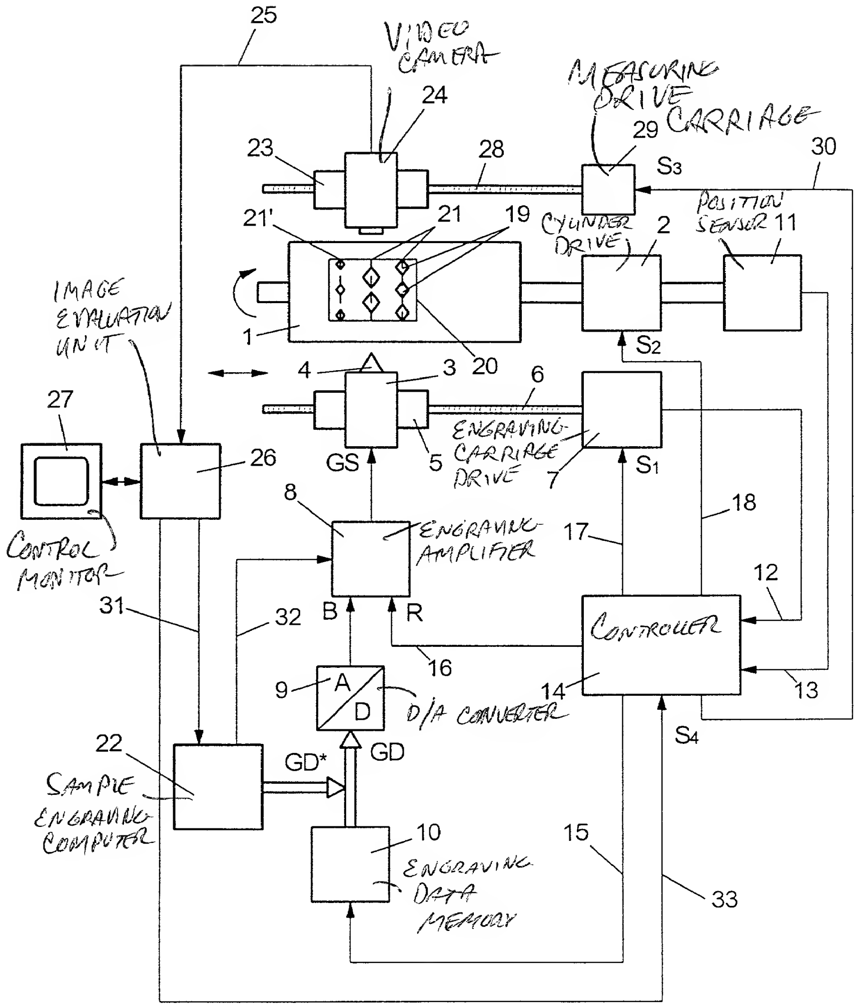
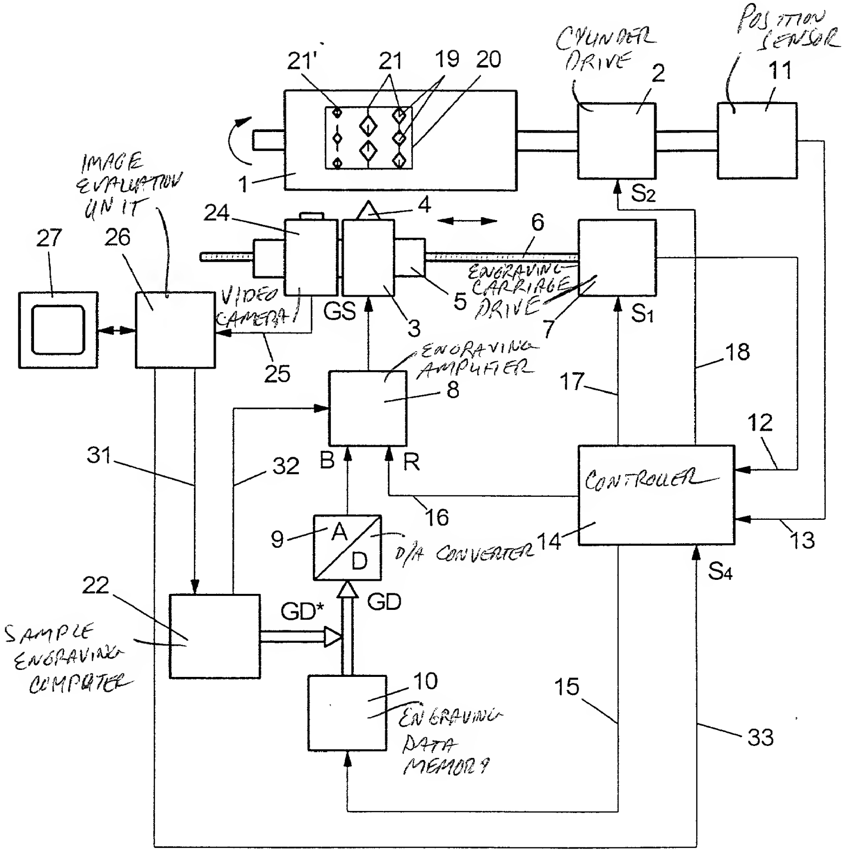


Fig. 1



POSITION SENSOR
CYLINDER DRIVE
21'
21
19
20
2
11
1
IMAGE EVALUATION UNIT
24
4
6
27
26
ENGRAVING CARRIAGE DRIVE
VIDEO CAMERA
GS
5
3
7
S2
S1
25
ENGRAVING AMPLIFIER
18
17
8
12
31
32
B
R
CONTROLLER
16
9
A
D
D/A CONVERTER
14
13
S4
22
GD*
GD
SAMPLE ENGRAVING COMPUTER
10
ENGRAVING DATA MEMORY
15
33

Fig. 11

09/744581

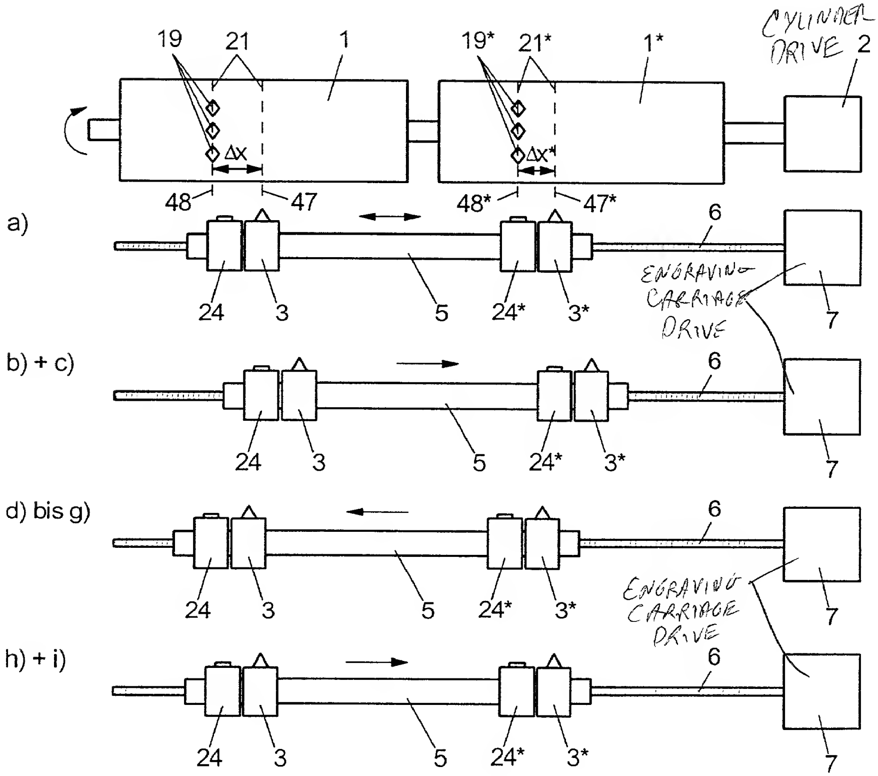


Fig. 13

09/744581

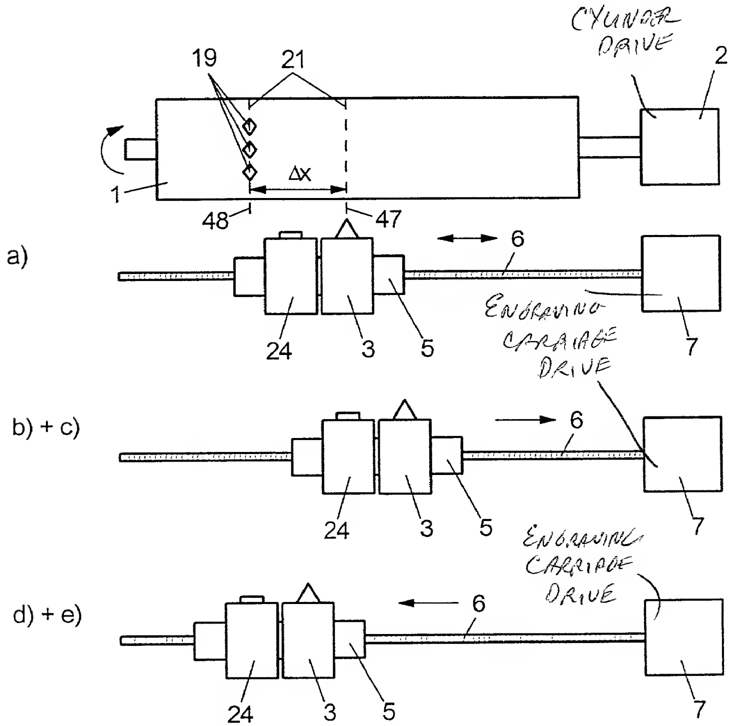


Fig. 12

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

SUBMISSION OF FORMAL DRAWINGS

APPLICANT(S): ERNST-RUDOLF GOTTFRIED WEIDLICH

SERIAL NO.: 09/744,581 GROUP ART UNIT:

FILED: January 25, 2001

TITLE: **"METHOD FOR GENERATING AND EVALUATING A SAMPLE ENGRAVING"**

Assistant Commissioner for Patents,

Washington, D. C. 20231

SIR:

Applicant herewith submits nine sheets of Formal Drawings (Figures 1-13) for the above application with the required changes.

Respectfully submitted,

Brett A. Valiquet (Reg). #27,841)

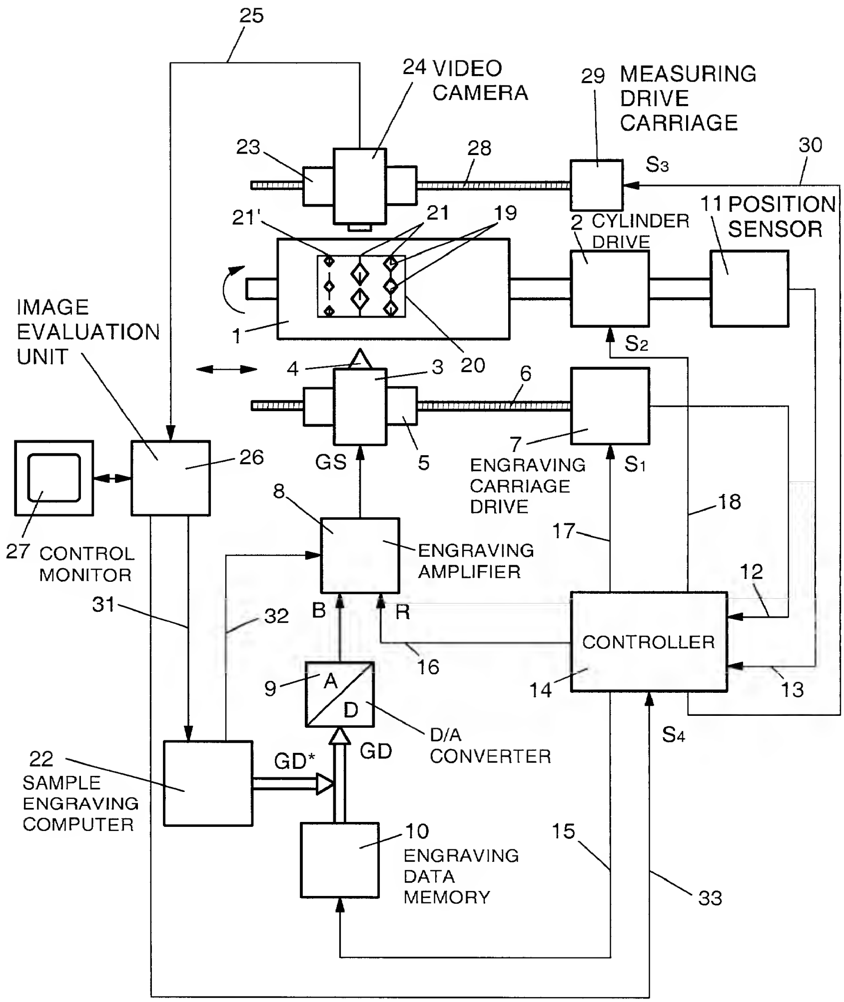
Brett A. Valiquet
Schiff Hardin & Waite
Patent Department
6600 Sears Tower
Chicago, Illinois 60606
Telephone: 312-258-5786
Attorneys for Applicant
CUSTOMER NO. 26574

I hereby certify that this correspondence is being deposited with the United States Postal Service as First Class Mail in an envelope addressed to: Assistant Commissioner for Patents, Washington, D. C. 20231 on March 5, 2001.

Brett A. Valiquet
Name of Applicants' Attorney

Signature

March 5, 2001
Date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24 VIDEO CAMERA
29 MEASURING DRIVE CARRIAGE
23
28
S3
30
21'
21
19
2 CYLINDER DRIVE
11 POSITION SENSOR
IMAGE EVALUATION UNIT
1
20
4
3
6
S2
26
GS
5
7
ENGRAVING CARRIAGE DRIVE
S1
27 CONTROL MONITOR
8
ENGRAVING AMPLIFIER
17
18
12
31
32
B
R
16
CONTROLLER
14
13
9
A
D
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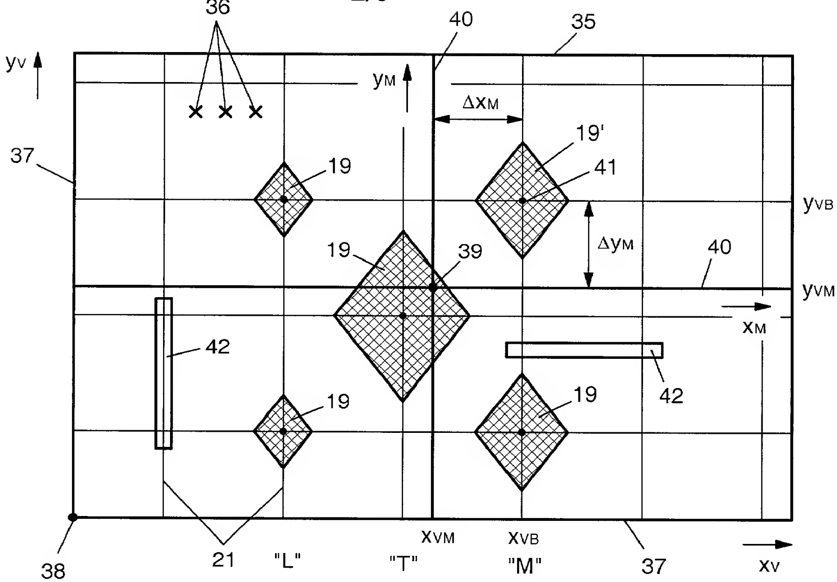
S4
22
SAMPLE ENGRAVING COMPUTER
GD*
GD
10
ENGRAVING DATA MEMORY
15
33

Fig. 1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35
yV
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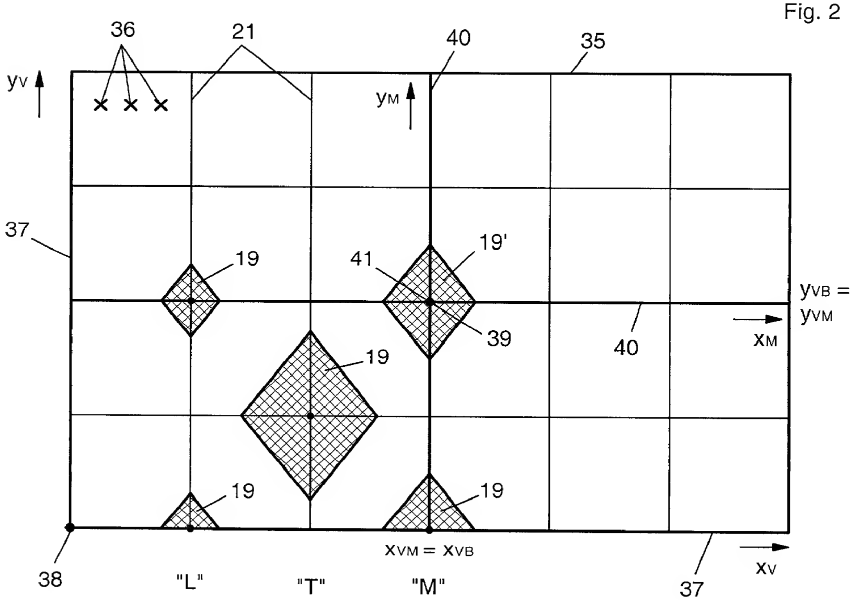
ΔxM
37
19'
19
41
yVB
ΔyM
19
39
40
yVM
xM
42
19
19
42
21
38
xVM
xVB
"L"
"T"
"M"
37
xV

Fig. 2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21
40
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yV
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37
19
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19'
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yVM
39
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19
38
xVM = xVB
"L"
"T"
"M"
37
xV

Fig. 8

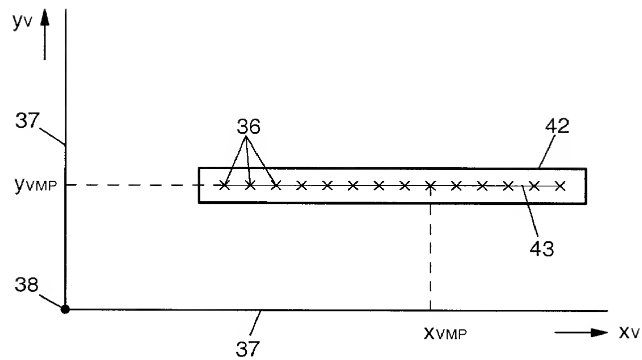


Fig. 3

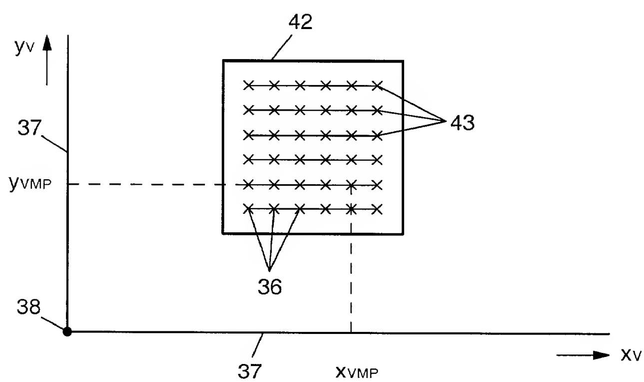
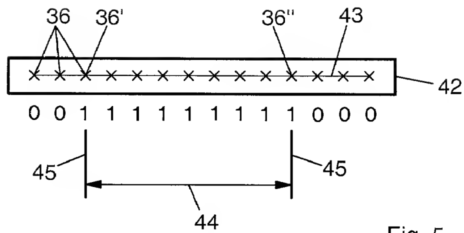


Fig. 4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36'
36''
43
42
0 0 1 1 1 1 1 1 1 1 1 0 0 0
45
45
44

Fig. 5

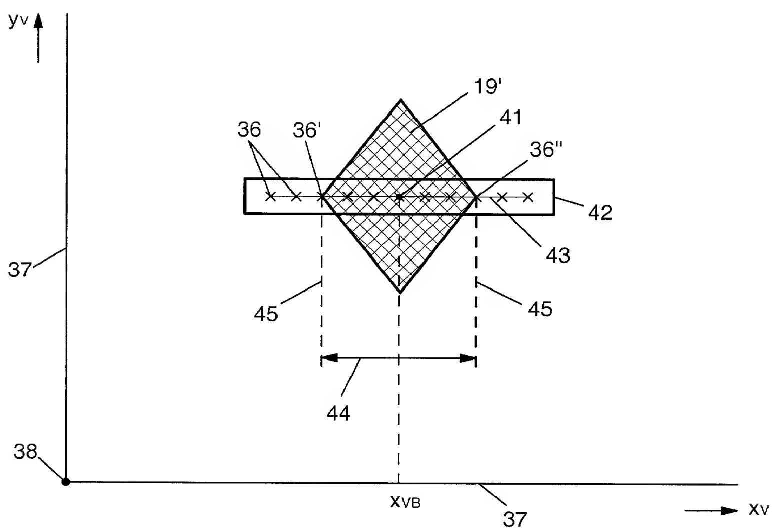

yv
19'
41
36
36'
36''
42
43
37
45
45
44
38
xVB
37
xv

Fig. 6

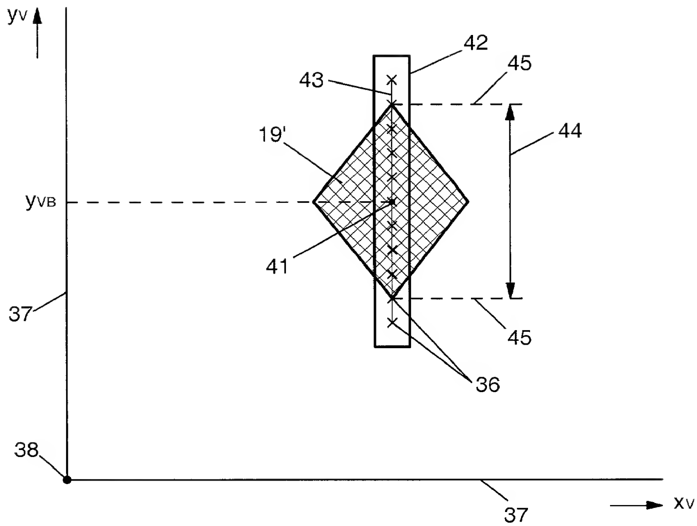


Fig. 7

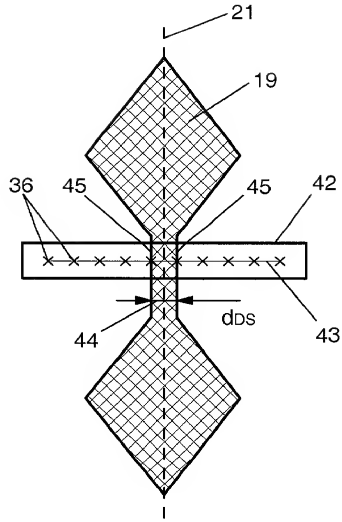


Fig. 9

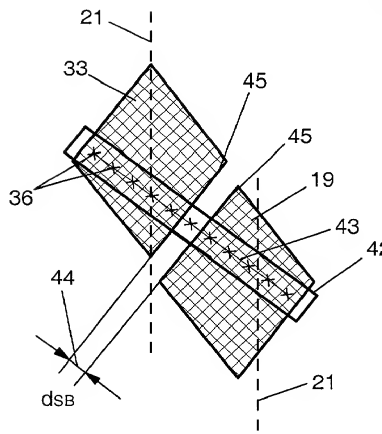
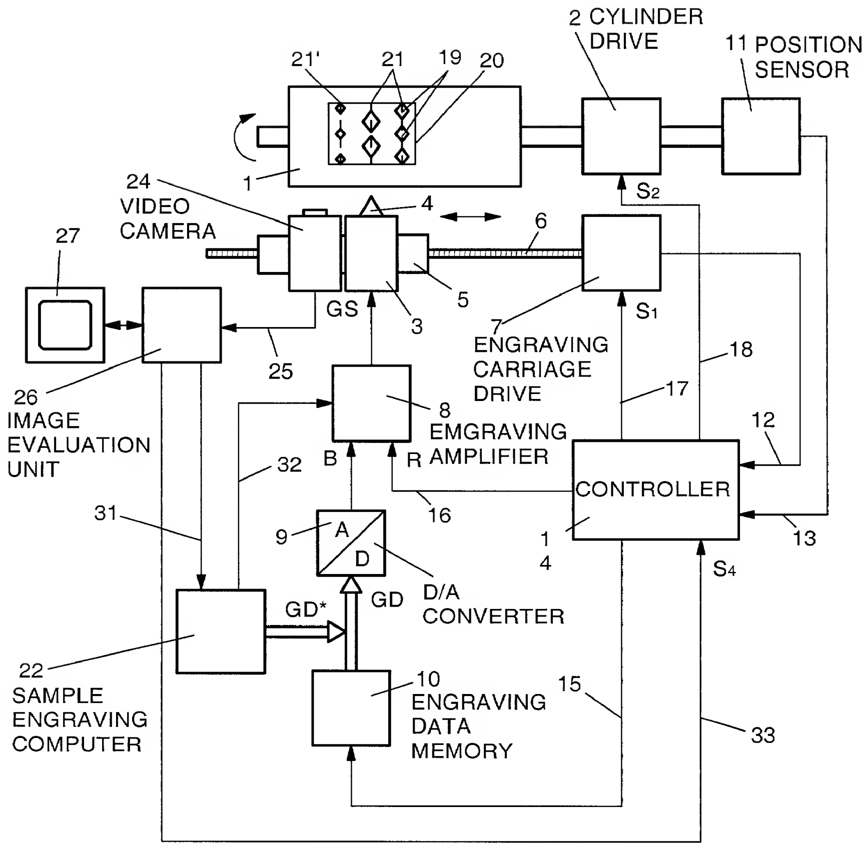


Fig. 10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21
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1
24 VIDEO CAMERA
4
6
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S2
5
GS
3
7 ENGRAVING CARRIAGE DRIVE
S1
25
18
26 IMAGE EVALUATION UNIT
8 EMGRAVING AMPLIFIER
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CONTROLLER
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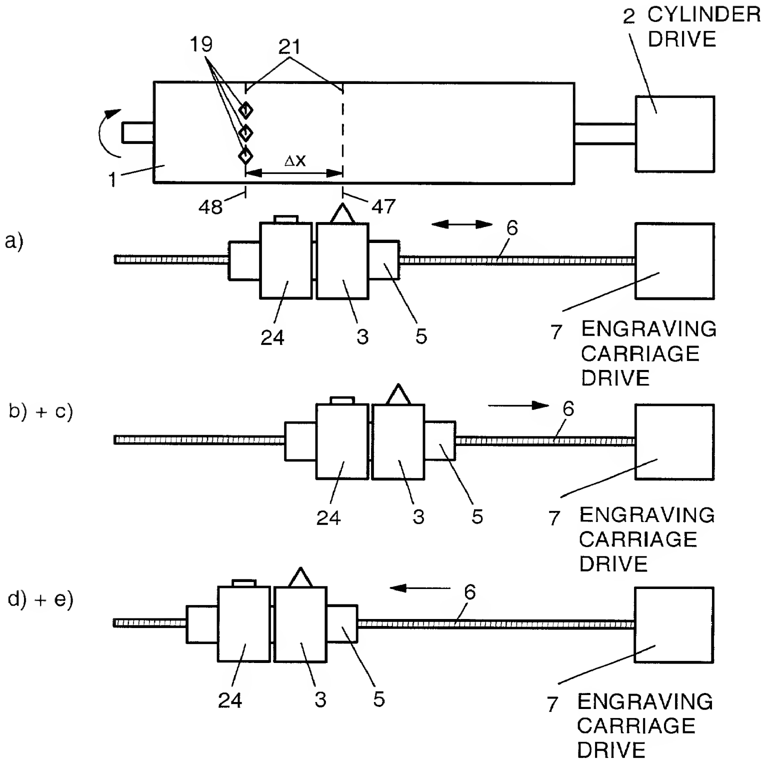
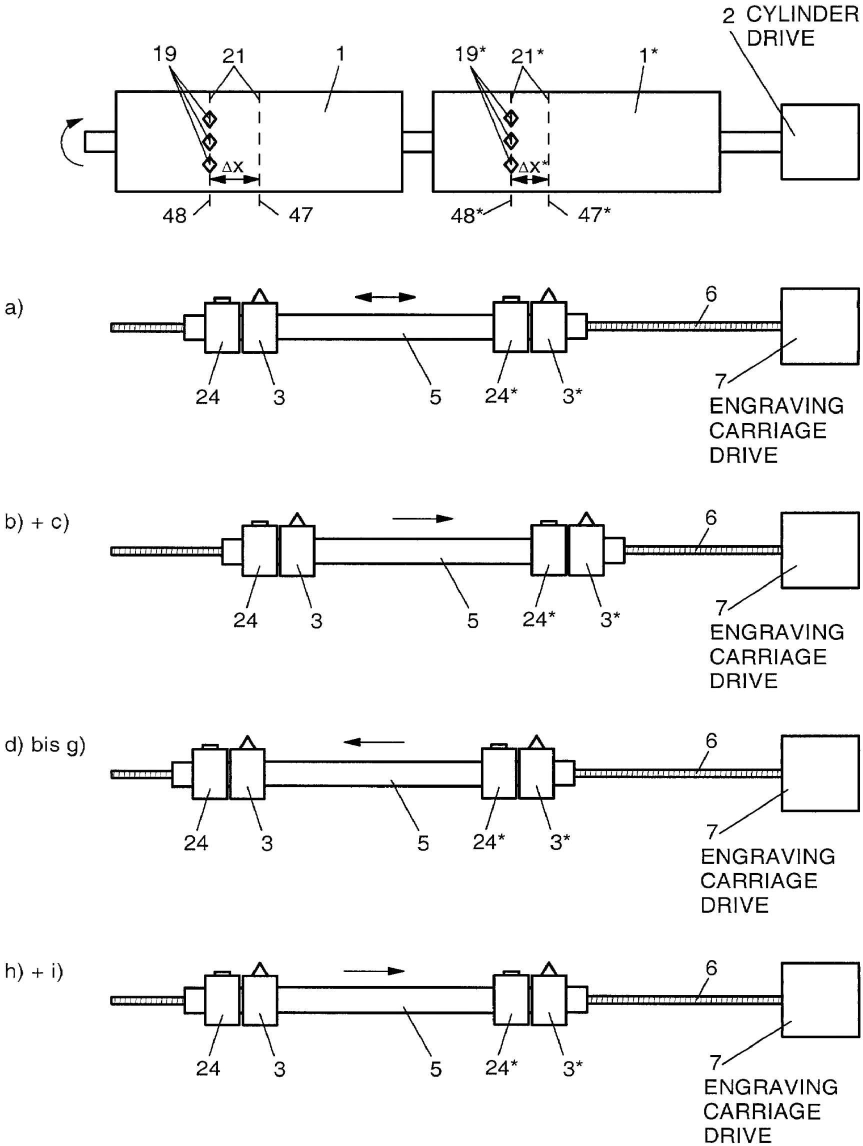
D/A CONVERTER
S4
GD*
GD
22 SAMPLE ENGRAVING COMPUTER
10 ENGRAVING DATA MEMORY
15
33

Fig. 11



2 CYLINDER DRIVE
19
21
1
ΔX
48
47
a)
6
24
3
5
7 ENGRAVING CARRIAGE DRIVE
b) + c)
6
24
3
5
7 ENGRAVING CARRIAGE DRIVE
d) + e)
6
24
3
5
7 ENGRAVING CARRIAGE DRIVE

Fig. 12


2 CYLINDER DRIVE
19
21
1
19*
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ΔX
ΔX*
48
47
48*
47*
a)
b) + c)
d) bis g)
h) + i)
6
7
ENGRAVING CARRIAGE DRIVE
24
3
5
24*
3*

Fig. 13

09/744581
500 Rec'd PCT/PTO 25 JAN 2001

SPECIFICATION

TITLE

METHOD FOR GENERATING AND EVALUATING A SAMPLE ENGRAVING

BACKGROUND OF THE INVENTION

The invention is in the field of electronic reproduction technology and is directed to a method for generating and evaluating a sample engraving in an electronic engraving machine for engraving printing cylinders for rotogravure.

In an electronic engraving machine, an engraving element with an engraving stylus as a cutting tool moves in an axial direction along a rotating printing cylinder. The engraving stylus controlled by an engraving control signal cuts a sequence of cups arranged in an engraving raster into the generated surface of the printing cylinder. The engraving control signal is formed by superimposition of image signal values, which represent the hues to be engraved between "light" white and "dark" black, with a periodic raster signal. Whereas the raster signal effects a vibrating lifting motion of the engraving stylus for generating the engraving raster, the image signal values determine the geometry values of the cups engraved into the printing cylinder.

The engraving control signal must be calibrated so that the engraved hues correspond to the hues defined by the image signal values. For that purpose, what is referred to as a sample engraving is implemented before the actual engraving, sample cups for predetermined hues being engraved into the printing cylinder in this sample engraving.

After the sample engraving, a measuring instrument is positioned on the engraved sample cups and their geometry values such as, for example, the transverse diagonals and longitudinal diagonals are measured.

The measured geometry values of the sample cups are then compared to the predetermined geometry values. Setting values are obtained from the comparison with which the engraving control signal is calibrated such that the geometry values of

the cups generated in the later engraving coincide with the geometry values required for reproduction with proper hues.

The PCT patent application serial number PCT/DE 98/01441 has already disclosed that a video camera with an image evaluation unit be employed for determining the geometry values of engraved sample cups, the geometry values in a video image of the sample cups registered with the video camera being measured with said image evaluation unit.

A prerequisite for an exact measurement is that the sample cups fall completely into the image excerpt registered by the video camera after a manual or automatic positioning of the video camera given optimum image resolution. This condition is not always met in practice, particularly after changing engraving styli, and mismeasurements are the result.

SUMMARY OF THE INVENTION

It is therefore an object of the present invention to improve a method for generating and evaluating a sample engraving in an electronic engraving machine for engraving printing cylinders for rotogravure with respect to the positioning of a measuring instrument, particularly a video camera, such that a high-precision, automatic measuring of the sample cups generated in the sample engraving is assured.

According to the method of the present invention for generating and evaluating a sample cut in an electronic engraving machine for engraving printing cylinders for rotogravure, an engraving control signal for driving an engraving stylus of an engraving element is formed from engraving data which represent hues to be engraved between "light" and "dark" and a periodic raster signal for generating an engraving raster. With the engraving stylus, a sequence of cups arranged in the engraving raster is engraved into the printing cylinder engraving line by engraving line, geometry values of the cups determining the engraved hues. Sample cups for predetermined hues are engraved before actual engraving. A video camera is positioned to a predetermined, axial measurement position and with which a video

image of the sample cups is registered. One of the engraved sample cups is selected. A positional deviation of a measurement location of the selected sample cup from a reference location in the video image is identified as a position error. The identified position error is corrected by at least one of axial displacement of the video camera into a new measurement position and by turning the printing cylinder such that the measurement location of the selected sample cup lies at least in a region of the reference location of the video image. Geometry values of at least the selected sample cup are subsequently measured and these geometry values are compared to geometry values of the predetermined hues. The engraving control signal is calibrated dependent on a result of the comparison such that the engraved hues correspond to the predetermined hues.

The invention is explained in greater detail below on the basis of Figures 1 through 13.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 shows schematically an electronic engraving machine for engraving printing forms with a first exemplary embodiment for the arrangement of a measuring instruments for measuring engraved sample cups;

Figure 2 is a video image of engraved sample cups before correction of positioning errors of a video camera;

Figure 3 shows the formation of a stripe-shaped measuring field;

Figure 4 shows the formation of a quadratic measuring field;

Figure 5 is a graphic presentation for automatically determining a measuring distance within a measurement field;

Figure 6 is a graphic presentation for measuring the positioning errors of a sample cup in one coordinate direction;

Figure 7 is a graphic presentation for measuring the positioning errors of a sample cup in the other coordinate direction;

Figure 8 is a video image of engraved sample cups after a correction of positioning errors of a video camera;

Figure 9 is a graphic presentation for measuring a pilot cut;

Figure 10 is a graphic presentation for measuring a web width;\

Figure 11 shows schematically an electronic engraving machine for engraving printing forms with a second exemplary embodiment for the arrangement of a measuring instruments for measuring engraved sample cups;

Figure 12 shows the method sequence given an engraving machine; and

Figure 13 shows the method sequence given an engraving machine working in twin mode.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Figure 1 schematically shows an electronic engraving machine for engraving printing forms for rotogravure with a first exemplary embodiment for a measuring instrument for measuring sample cups generated in a sample engraving. For example, the engraving machine is a HelioKlischograph® of Hell Gravure Systems GmbH, Kiel, Germany.

A printing cylinder 10 is rotationally driven by a cylinder drive 2. The engraving on the printing cylinder 1 occurs with an engraving element 3 having an engraving stylus 4 as cutting tool. The engraving element 3 is located on an engraving carriage 5 that can be moved in axial direction of the printing cylinder 1 by an engraving carriage drive 7 on the basis of a spindle 6.

The engraving stylus 4 cuts a sequence of cups arranged in an engraving raster into the generated surface of the rotating printing cylinder 1 engraving line by engraving line while the engraving carriage 5 with the engraving element 3 moves along the printing cylinder 1 in the axial direction.

The engraving stylus 4 is controlled by an engraving control signal GS. The engraving control signal GS is formed in an engraving amplifier 8 by superimposition of a periodic raster signal R with image signal values B that represent the hues of the cups to be engraved between "light" and "dark". Whereas the periodic raster signal R effects a vibrating lifting motion of the engraving stylus 4 for

generating the engraving raster, the image signal values B corresponding to the hues to be engraved determine the geometry values of the engraved cups.

The analog image signal values B are acquired in a D/A converter 9 from engraving data GD that are deposited in an engraving data memory 10 and read therefrom engraving line by engraving line and supplied to the D/A converter 9. Each engraving location in the engraving raster has an engraving datum GD of at least one byte allocated to it that, as engraving information, contains the hue between "light" and "dark" to be engraved.

The generated surface of the printing cylinder 1 has an engraving coordinate system allocated to it whose abscissa axis is oriented in axial direction of the printing cylinder 1 (feed direction of the engraving element) and whose ordinate axis is oriented in circumferential direction of the printing cylinder 1 (direction of the engraving lines). The engraving coordinates x_G and y_G of the engraving coordinate system define the engraving locations for the cups on the printing cylinder 1. The engraving carriage drive 7 generates the engraving coordinates x_G that determine the axial positions of the engraving lines on the printing cylinder 1. A position sensor 11 mechanically coupled to the cylinder drive 2 generates the corresponding engraving coordinates y_G that indicate the relative circumferential positions of the rotating printing cylinder 1 relative to the engraving stylus 4. The engraving coordinates x_G and y_G of the engraving locations are supplied to a controller 14 via lines 12, 13.

The controller 14 controls the addressing and the readout of the engraving data GD from the engraving data memory 10 dependent on the engraving coordinates x_G and y_G of the current engraving locations via a line 15. The controller 14 also generates the raster signal R on a line 16 with the frequency required for generating the engraving raster. For axial positioning of the engraving element 3 relative to the printing cylinder 1 and for controlling the feed motion of the engraving element 3 during engraving, corresponding control commands S_1 on a line 17 to the engraving carriage drive 7 are generated in the controller 14. Further control commands S_2 on a line 18 control the cylinder drive 2.

For engraving sample cups 19 on juxtaposed engraving lines 21 in a sample engraving region 20 of the printing cylinder 1 that is not used for the later engraving, the engraving machine comprises a sample engraving computer 22 that supplies the required engraving data GD* to the D/A converter 9.

For measuring the geometry values of the sample cups 19 generated in the sample engraving, a measuring carriage 23 displaceable in the axial direction of the printing cylinder 1 and having a video camera 24 for recording a video image of the sample cups 19, an image evaluation unit 26 connected to the video camera 24 via a line 25 for measuring the registered sample cups 19 and a control monitor 27 for monitoring the video image are present in the first exemplary embodiment shown in Figure 1.

The geometry values of the sample cups to be measured can, for example, be the transverse diagonals, the longitudinal diagonals, the widths of the pilot cuts and the web widths.

The video image of the sample cups 19 can be made given a stationary printing cylinder 1 or during the rotation of the printing cylinder 1, given a corresponding synchronization. The measuring carriage 23 with the video camera 24 can be axially positioned onto the sample cups 19 generated in the sample engraving region, being positioned with a spindle 28 and a measuring carriage drive 29. The measuring carriage drive 29 is controlled by the controller 140 by control commands S_3 on a line 30.

The geometry values of the sample cups 19 measured in the image evaluation unit 26 on the basis of the video image are transmitted to the sample engraving computer 22 via a line 31. Setting values for calibrating the engraving amplifier 8 are acquired in the sample engraving computer 22 by comparing the measured, actual geometry values to the predetermined, rated geometry values. The engraving control signal GS in the engraving amplifier 8 is then calibrated such with the setting values, which are supplied to the engraving amplifier 8 via a line 32, that

the cups actually generated in the later engraving of the printing cylinder 1 correspond to the cups required for an engraving with correct hues.

The calibration of the engraving control signal GS can occur automatically before the engraving or online during the engraving. The calibration, however, can also be manually implemented in that the sample engraving computer 22 merely displays the setting values that have been determined, these then being manually transferred to the engraving amplifier 8.

The generation and evaluation of a sample engraving sequences according to the following method steps:

In a method step **[A]** for the implementation of the sample engraving, the engraving element 3 with the engraving carriage 5 is axially displaced from a zero position onto a rated position at which the first engraving line 21' is to be engraved within the sample engraving region 20 provided for the sample engraving, being manually or automatically displaced with the engraving carriage drive 7.

In a method step **[B]**, the sample engraving computer 22 calls, for example, the engraving data GD* for the rated hues "dark", "light" and for at least one "mid-hue" between "light" and "dark" for engraving the sample cups 19. The engraving data GD* that have been called are converted into the engraving control signal GS for the engraving element 3. Proceeding from the first engraving line 21', the engraving element 3 respectively engraves at least one sample cup 19 for "light", "dark" and "mid-hue" on juxtaposed engraving lines 21. A plurality of sample cups 19 of the same hue are preferably engraved in circumferential direction on each engraving line 21, 21' within the expanse of the sample engraving region 20.

In a method step **[C]**, the video camera 24 with the measuring carriage 23 is manually or automatically displaced with the measuring carriage drive 29 from a zero position onto a predetermined measuring position that corresponds to the rated position of that engraving line 21 whose sample cups 19 are to be measured, for example onto the rated position of the first engraving line 21', being displaced for measuring the geometry values of the engraved sample cups 19.

Let the video camera 24 be adjusted such that, given coincidence of the measuring position and the rated position of an engraving line 21, the sample cups 19 of this engraving line to be measured lie on a reference location in the middle of the video image, for example on the ordinate axis of a measurement coordinate system with the coordinate origin in the middle of the image. It is thereby assured that the sample cups 19 are fully covered by the video camera 24 given optimum image resolution in order to achieve a high measuring precision.

In practice, however, the engraving stylus 4 must be occasionally replaced. Without involved readjustment, the original engraving stylus position can be lost when changing engraving styli, and the sample cups 19 are engraved at engraving locations that deviate from the rated engraving locations defined by the engraving coordinate values x_G and y_G. In this case, the sample cups 19 are engraved on engraving lines 21, 21' whose axial actual positions are offset compared to the predetermined rated positions. Given displacement of the video camera 24 onto a predetermined measuring position that coincides with a predetermined rated position of an engraving line 21, 21', positive and negative position errors Δx_M and Δy_M of the sample cups 19 engraved on the offset engraving line 21, 21' compared to the measurement coordinate system therefore appear in the video image. Due to these position errors Δx_M and Δy_M, it can therefore occur that the sample cups 19 do not fully lie in the video image given optimum image resolution, and imprecisions in the measurement of the geometry values of the sample cups are the result.

In order to improve the measuring precision, it is therefore proposed that one of the engraved sample cups 19 be selected, the position errors Δx_M and Δy_M of the selected sample cup being measured in a method step **[D]** as coordinate-related distances of a measuring location of the sample cup from a reference location in the video image, for example relative to the coordinate origin of the measurement coordinate system, and the identified position errors Δx_M and Δy_M are corrected such before measuring the geometry values of at least the selected sample cup in a method step **[E]** by displacing the video camera 24 onto a new measuring position and/or by

turning the printing cylinder 1 such that the measuring location of the selected sample cup 19' lies in the reference location of the video image.

In the method step **[D]**, the position errors Δx_M and Δy_M of the measuring location of the selected sample cup 19' that have arisen in the positioning of the video camera 24 to a predetermined measuring position are first measured relative to the coordinate origin of the measurement coordinate system in the image evaluation unit 26 on the basis of the registered video image.

For example, a sample cup 19 that represents a "mid-hue" M or, on the other hand, some other sample cup 19 as well should therefore be selected as sample cup 19' whose measuring location is to be shifted into the coordinate origin of the measurement coordinate system. Dependent on which geometry values are to be determined, the mid-point of the cup area, the mid-point of the transverse diagonals or longitudinal diagonals of the sample cup or, on the other hand, the mid-point of a web or pilot cut to be measured should be defined as a measuring location of the selected sample cup 19'. The measurement of the position errors Δx_M and Δy_M of the selected sample cup in the video image is explained on the basis of Figure 2.

Figure 2 shows a registered video image 35 of the engraved sample cups 19 with the orthogonal engraving raster composed of horizontal and vertical raster lines, whereby the vertical raster lines are the engraving lines 21. For example, engraved sample cups 19 for "light" L, "dark" T and "mid-hue" M are shown on three juxtaposed engraving lines 21. The centers of gravity of the sample cups 19 lie on the intersections of the raster lines of the engraving raster.

The video image 35 is composed of a plurality of pixels 36 whose positions in the video image 35 are defined by the image coordinates x_V and y_V of an image coordinate system 37 allocated to the video image 35. The coordinate axes of the image coordinate system 37 is directed in the longitudinal and the transverse expanse of the video image 35, and the coordinate origin 36 lies in a corner point of the video image 35. The coordinate axes of the measurement coordinate system 4 are aligned parallel to the coordinate axes of the image coordinate system 37. The

coordinate origin 39 of the measurement coordinate system 40, which lies in the mid-point of the video image 35 has the image coordinates x_{VM} and y_{VM} in the image coordinate system 37. The following coordinate-related relationship thus derives:

$$x_M = x_V - x_{VM}$$

$$y_M = y_V - y_{VM}$$

For example, the sample cup 19' with the mid-point of the cup area as measuring location 41 that has the image coordinates x_{VB} and y_{VB} in the image coordinate system 37 is selected. The position errors Δx_M and Δy_M of the selected sample cup 19' in the measurement coordinate system 40 thus derive as:

$$\Delta x_M = x_{VB} - x_{VM}$$

$$\Delta y_M = y_{VB} - y_{VM}$$

Every pixel 36 has a video datum VD of, for example, 8 bits characterizing the respective gray scale value allocated to it, so that a total of 254 gray scale values can be distinguished between “black” VD=0 and “white” VD=255. By filtering or with thresholds, the gray scale values can be reduced such to two values that, for example, the video datum VD = 0 is allocated to those pixels that fall onto the generated surface of the printing cylinder 1 and the video datum VD = 1 is allocated to those pixels that fall onto the cup areas of the sample cup 19. The contour (density discontinuity) of a cup area is thereby characterized by the change of the video datum from “0" to “1" or from “1" to “0".

For automatically determining the image coordinate values x_{VB} and y_{VB} of the measuring location 41 of the selected sample cup 19' in the image coordinate system 37, for example a stripe-shaped measurement field 42 is defined that can be shifted across the video image and that can be aligned with an arbitrary orientation in the image coordinate system 37.

The measurement field 42 is composed of at least one measurement line 43, preferably of a plurality of measurement lines 43 proceeding parallel to one another, and each measurement line 43 comprises a plurality of pixels 36 whose position in the image coordinate system 37 is respectively defined by an image

coordinate pair x_{VMP} and y_{VMP}, so that the position in the image coordinate system 37 can also be determined for each pixel 36 within the measurement lines 43. The longitudinal expanse of the measurement field 42 amounts to at least the same as the spacing of two engraving lines 21. The spacings of the pixels 36 from one another respectively represent a length increment. By counting the pixels 36 within a measurement distance 44, the length of the measurement distance 44 can thus be measured as a multiple of the length increment.

Figure 3 shows the formation of a stripe-shaped measurement field 42 that, for example, is composed of measurement lines 43 with fourteen pixels 36.

Figure 4 shows the formation of a quadratic measurement field 42 that, for example, is composed of 6 measurement lines 43 with respectively 6 pixels 36 in each measurement line 43.

As already explained, the edges of the cup area of a sample cup 19 in the registered video image 35 form a contour 45. The measurement distance 44, for example for measuring the maximum transverse diagonal or the maximum longitudinal diagonal of the sample cup 19, thus derives from the respective spacing of the corresponding contours 45 from one another.

The end pixels 36', 36" of the measurement distance 44 are advantageously determined with the assistance of the measurement field 42 itself on the basis of an automatic recognition of two neighboring contours 45, in that the respective video data VD of two successive pixels 36 of the measurement line 43 are investigated for a change of the video data VD.

Figure 5 shows the measurement band 42 with one measurement line 43 and two contours 45 spaced from one another. The video data VD allocated to the individual pixels 36 are also shown, whereby the contours 45 are characterized by the change “0' to “1" and “1" to “0". The corresponding end pixels 36', 36" of the measurement distance 44, which is composed of 9 pixels 36 in the illustrated case, are determined by an automatic contour recognition.

Figure 6 shows the measurement of the image coordinate value x_{VB} of the measurement location 41 of the selected sample cup 19' with the stripe-shaped measurement field 42, which is composed of one measurement line 43. In the illustrated example, the measurement location 41 is the mid-point of the cup area of the selected sample cup 19'. The measurement field 42 has its longitudinal expanse aligned in the direction of the abscissa of the image coordinate system 37 and is shifted onto the selected sample cup 19'. The end pixels 36', 36" of the measurement distance 44 are determined by the automatic recognition of the contour 45 of the cup area of the selected sample cup 19'. The plurality of pixels 36 that devolve onto the measurement distance 44 is thus known, and the middle pixel 360 of the measurement distance 440 then represents the measurement location 41 of the selected sample cup 19'. The image coordinate value x_{VB} of the measurement location 41 of the selected sample cup 19' in the image coordinate system 37 then derives as a coordinate value of the middle pixel of the measurement distance 44.

Figure 7 shows the corresponding measurement of the image coordinate value y_{VB} of the measurement location 41 of the selected sample cup 19' with the measurement field 42 that has its longitudinal expanse aligned in the direction of the ordinate of the image coordinate system 37 for this purpose. In the illustrated example, the measurement location 41 is again the mid-point of the cup area. The image coordinate value y_{VB} of the measurement location 41 of the selected sample cup 19' then derives from the identified coordinate value of the middle pixel 36 of the measurement distance 44.

Advantageously, the selected sample cup 19' that represents a defined hue is automatically "sought" in the video image 35 with the assistance of a measurement field 42 composed of a plurality of measurement lines 43. For that purpose, the cup area of the sample cup 19' is prescribed according to the predetermined hue as a plurality of pixels 36. A corresponding measurement field is shown in Figure 4. The size of the measurement field 42 at least corresponds to the size of the predetermined cup area, so that all pixels 36 falling into the cup area can be covered by the

measurement field 42. The measurement field 42 is shifted across the video image 35 from engraving location to engraving location of the sample cups 19. At every engraving location, the cup area of the corresponding sample cup 19 is measured with the assistance of the measurement field 42 in that the pixels 36 counted in the individual measurement lines 43 are added up and compared to the pixel plurality of the predetermined cup area. A sample cup 19 has been identified as selected sample cup 19' when the predetermined and the measured cup area agree.

In a method step **[E]**, the measured position errors Δx_M and Δy_M are compensated by displacing the measurement carriage 23 and/or by turning the printing cylinder 1. The compensation can ensue manually under visual control of the video image on the control monitor 27 or with an automatic control of cylinder drive 2 and/or engraving carriage drive 7 via the controller 14. The image evaluation unit 23 thereby supplies a corresponding control command S_4 to the controller 14 via a line 33 when the evaluation of the video image has yielded that the measurement location 41 of the selected sample cup 19' is congruent with the coordinate origin 38 of the measurement coordinate system 40, as a result whereof an exact determination of the geometry values of the engraved sample cups 19 is assured.

Figure 8 shows the video image 35 after the correction of the position errors Δx_M and Δy_M. The measurement location 41 of the selected sample cup 19' is now congruent with the coordinate origin 38 of the measurement coordinate system 40 in the video image 35.

In most instances, it suffices to merely compensate the axial position error Δx_M by shifting the measurement carriage 23 since a plurality of sample cups 19 for a hue are usually engraved in engraving line direction and, thus, at least one sample cup 19 of a hue lies in the pickup area of the video camera 24.

After compensation of the position errors Δx_M and Δy_M, the determination of the geometry values of the engraved sample cups 19 occurs in a method step **[F]** with an automatic evaluation in the image evaluation unit 26 of the video image 35 according to Figure 8 registered with the video camera 24. The measurement is

advantageously implemented with the assistance of the same measurement field 42 that was already employed for the measurement of the position errors Δx_M and Δy_M.

For measuring the maximum transverse diagonal d_{Qmax}, which corresponds to the measurement distance 44 in Figure 6, or an arbitrary transverse diagonal d_Q of a sample cup 19, the measurement field – as already shown in Figure 6 – has its longitudinal expanse aligned in the direction of the abscissa of the measurement coordinate system 40.

For measuring the maximum longitudinal diagonal d_{Lmax}, which corresponds to the measurement distance in Figure 7, or an arbitrary longitudinal diagonal d_L of a sample cup 19, the measurement field 42 – as shown in Figure 7 – has its longitudinal expanse aligned in the direction of the ordinate of the measurement coordinate system 40.

For measuring the pilot cut d_{DS}, i.e. the width of the engraving channel in the direction of the abscissa of the measurement coordinate system 40 that connects two sample cups 19 engraved on an engraving line 21, the measurement field 42 again has its longitudinal expanse aligned in the direction of the abscissa. The measurement of the pilot cut d_{DS} is graphically shown in Figure 9.

For measuring the web width d_{SB}, i.e. the width of the material that has remained standing between two deep cups engraved on neighboring engraving lines 21, 21', the measurement field is expediently turned such that it has its longitudinal expanse aligned approximately perpendicularly to the course of the web. The measurement of the web width d_{SB} is graphically shown in Figure 10.

Figure 11 schematically shows an electronic engraving machine for engraving printing forms with a second exemplary embodiment for a measuring device for measuring engraved sample cups 19.

In this exemplary embodiment, the video camera 24 – differing from what is shown in Figure 1 – is not arranged on a separate measurement carriage 23 but on the engraving carriage 7 next to the engraving element 3 with a structurally conditioned axial spacing B from the engraving stylus 4 of the engraving element 3.

The video image 35 of the engraved sample cups 19 is picked up, for example, via a lightguide cable whose light entry face is arranged in a plane proceeding perpendicular to the axial direction and through the tip of the engraving stylus 4 of the engraving element 3. Alternatively thereto, the video image 35 of the engraved sample cups 19 can also be directly registered with the video camera 24. In this case, the video camera 24 mounted on the engraving carriage 5 is first shifted by the axial distance B onto the predetermined measurement position in the sample engraving region 20 with the engraving carriage drive 7 after engraving the sample cups 19. Subsequently, the position errors Δx_M and Δy_M are measured and corrected and the engraved sample cups 19 are measured.

Figure 12, in summary, schematically shows the work execution at an engraving machine, whereby it is assumed that the video camera 24 is mounted next to the engraving element 3 on the engraving carriage 5 according to the exemplary embodiment according to Figure 11.

a) Displacing the engraving element 3 with the engraving carriage 5 onto a predetermined, axial rated position 47 of an engraving line 21 to be engraved and engraving of sample cups 19 on an engraving line 21 in an axial actual position 48 that, due to an axial position error Δx, deviates from the rated position 47, according to method steps **[A]** and **[B]**.

b) Positioning the video camera 24 to the predetermined measurement position 47, which coincides with the predetermined rated position 47 of the engraving line 21, by displacing the engraving carriage 5 according to method step **[C]**.

c) Measuring the position error Δx of the video camera 24 in the predetermined measurement position 47 according to method step **[D]**.

d) Correction of the position error Δx of the video camera 24 by displacing the engraving carriage 5 into a new measurement position 48 according to method step **[E]** and

e) measuring the engraved sample cups 19 that were engraved on the engraving line 21 in the actual position 48 at the new measurement position 48 of the video camera 24 according to method step **[F]**.

The method can preferably also be utilized in the engraving of a plurality of engraving lanes lying juxtaposed in axial direction on a printing cylinder with a respectively allocated engraving element and in what is referred to as the twin mode of the engraving machine.

When engraving a plurality of engraving lanes on a printing cylinder 1 with a respectively allocated engraving element 3, a separate sample engraving must be implemented for each engraving element 3. For measuring the sample engravings, let the engraving machine be equipped with the displaceable measurement carriage 23 with the video camera 24 according to the exemplary embodiment of Figure 1. For measuring the individual sample engravings in each engraving lane, the video camera 24 is respectively axially displaced onto the individual measurement positions by the width of an engraving lane. In this case, the above-explained method steps **[A]** through **[F]** are implemented in every measurement position. Of course, a video camera according to the exemplary embodiment of Figure 11 can also be allocated to each engraving element 3.

In what is referred to as the twin mode of an engraving machine, two printing cylinders 1, 1* are mechanically coupled to one another, these being engraved with a respective engraving element 3, 3*. The engraving element 3, 3* are mounted on the shared engraving carriage 5 with a fixed spacing from one another, said engraving carriage 5 moving axially along both printing cylinders 1, 1*. A sampling engraving is engraved on the appertaining printing cylinder 1, 1* with each engraving element 3, 3*. For measuring the sample engravings, let the engraving element 3, 3* comprise a video camera 24, 24* on the engraving carriage 5 next to each engraving element 3, 3* according to the exemplary embodiment of Figure 11. A modified work sequence derives in this case.

Figure 13 schematically shows the modified work sequence at an engraving machine working in twin mode, whereby it is assumed that a respective video camera 24, 24* is mounted on the shared engraving carriage 5 next to the engraving element 3, 3* according to the exemplary embodiment of Figure 11.

a) Displacing the engraving elements 3, 3* with the shared engraving carriage 5 onto predetermined, axial rated position 47, 47* of engraving lines 21, 21* to be engraved and engraving sample cups 19, 19* on the engraving lines 21, 21* in axial actual positions 48, 48* that deviate from the rated positions 47, 47* due to axial position errors Δx and Δx^*, according to method steps **[A]** and **[B]**.

b) Positioning the first video camera 24 to a predetermined, first measurement position 47 that coincides with the predetermined, first rated position 47 of an engraving line 21 by displacing the shared engraving carriage 5 according to method step **[C]**.

c) Measuring the position error Δx of the first video camera 24 in the predetermined, first measurement position 47 according to method step **[D]**.

d) Correcting the measured position error Δx of the first video camera 24 by displacing the shared engraving carriage 5 into a new first measurement position 48 according to method step **[E]**.

e) Measuring the geometry values of the sample cups 19 engraved on the first printing cylinder 1 that were engraved on the engraving line 21 in the first actual position 48 at the new, first measurement position 50 of the first video camera 240 according to method step **[F]**.

f) Measuring the position error Δx^* of the second video camera 24* in the momentary position of the shared engraving carriage 5 according to method step **[D]**.

g) Calculating a new position error Δx^*_{new} for the second video camera 24*.

h) Correcting the calculated position error Δx^*_{new} of the second video camera 24* into a new, second measurement position 48* by displacing the shared engraving carriage 5 according to method step **[E]**, and

i) measuring the geometry values of the sample cups 19 engraved on the second printing cylinder 1* that were engraved on the engraving line 21* in the second actual position 48* at the new, second measurement position 50* of the second video camera 24* according to method step **[F]**.

Although only a preferred embodiment has been shown, other related embodiments may be suggested by those skilled in the art. Also, various minor modifications might be suggested by those skilled in the art, and it should be understood that it is my wish to embody within the scope of the patent warranted hereon all such other embodiments and modifications as reasonably and properly come within the scope of my contribution to the art.

SPECIFICATION

TITLE

METHOD FOR GENERATING AND EVALUATING A SAMPLE ENGRAVING

BACKGROUND OF THE INVENTION

The invention is in the field of electronic reproduction technology and is directed to a method for generating and evaluating a sample engraving in an electronic engraving machine for engraving printing cylinders for rotogravure.

In an electronic engraving machine, an engraving element with an engraving stylus as **a** cutting tool moves in **an** axial direction along a rotating printing cylinder. The engraving stylus controlled by an engraving control signal cuts a sequence of cups arranged in an engraving raster into the generated surface of the printing cylinder. The engraving control signal is formed by superimposition of image signal values, which represent the hues to be engraved between "light" ~~(white)~~ **white** and "dark" ~~(black)~~ **black**, with a periodic raster signal. Whereas the raster signal effects ~~an~~ **a** vibrating lifting motion of the engraving stylus for generating the engraving raster, the image signal values determine the geometry values of the cups engraved into the printing cylinder.

The engraving control signal must be calibrated so that the engraved hues correspond to the hues defined by the image signal values. ~~To~~ **For** that ~~end~~ **purpose**, what is referred to as a sample engraving is implemented before the actual engraving, sample cups for predetermined hues being engraved into the printing cylinder in this sample engraving.

After the sample engraving, a measuring instrument is positioned on the engraved sample cups and their geometry values such as, for example, the transverse diagonals and longitudinal diagonals are measured.

The measured geometry values of the sample cups are then compared to the predetermined geometry values. Setting values are obtained from the comparison with which the engraving control signal is calibrated such that the geometry values of

the cups generated in the later engraving coincide with the geometry values required for reproduction with proper hues.

The PCT patent application serial number PCT/DE 98/01441 has already disclosed that a video camera with an image evaluation unit be employed for determining the geometry values of engraved sample cups, the geometry values in a video image of the sample cups registered with the video camera being measured with said image evaluation unit.

A prerequisite for an exact measurement is that the sample cups fall completely into the image excerpt registered by the video camera after a manual or automatic positioning of the video camera given optimum image resolution. This condition is not always met in practice, particularly after changing engraving styli, and mismeasurements are the result.

SUMMARY OF THE INVENTION

It is therefore an object of the present invention to improve a method for generating and evaluating a sample engraving in an electronic engraving machine for engraving printing cylinders for rotogravure with respect to the positioning of a measuring instrument, particularly a video camera, such that a high-precision, automatic measuring of the sample cups generated in the sample engraving is assured.

~~This object is achieved by the features of claim 1. Advantageous developments and improvements are recited in the subclaims.~~ **According to the method of the present invention for generating and evaluating a sample cut in an electronic engraving machine for engraving printing cylinders for rotogravure, an engraving control signal for driving an engraving stylus of an engraving element is formed from engraving data which represent hues to be engraved between "light" and "dark" and a periodic raster signal for generating an engraving raster. With the engraving stylus, a sequence of cups arranged in the engraving raster is engraved into the printing cylinder engraving line by engraving line, geometry values of the cups determining the engraved hues.**

Sample cups for predetermined hues are engraved before actual engraving. A video camera is positioned to a predetermined, axial measurement position and with which a video image of the sample cups is registered. One of the engraved sample cups is selected. A positional deviation of a measurement location of the selected sample cup from a reference location in the video image is identified as a position error. The identified position error is corrected by at least one of axial displacement of the video camera into a new measurement position and by turning the printing cylinder such that the measurement location of the selected sample cup lies at least in a region of the reference location of the video image. Geometry values of at least the selected sample cup are subsequently measured and these geometry values are compared to geometry values of the predetermined hues. The engraving control signal is calibrated dependent on a result of the comparison such that the engraved hues correspond to the predetermined hues.

The invention is explained in greater detail below on the basis of Figures 1 through 13.

~~Shown are:~~ **BRIEF DESCRIPTION OF THE DRAWINGS**

Figure 1 **shows schematically** an electronic engraving machine for engraving printing forms with a first exemplary embodiment for the arrangement of a measuring instruments for measuring engraved sample cups~~, shown schematically~~;

Figure 2 **is** a video image of engraved sample cups before correction of positioning errors of a video camera;

Figure 3 **shows** the formation of a stripe-shaped measuring field;

Figure 4 **shows** the formation of a quadratic measuring field;

Figure 5 **is** a graphic presentation for automatically determining a measuring distance within a measurement field;

Figure 6 **is** a graphic presentation for measuring the positioning errors of a sample cup in one coordinate direction;

Figure 7 **is** a graphic presentation for measuring the positioning errors of a sample cup in the other coordinate direction;

Figure 8 **is** a video image of engraved sample cups after a correction of positioning errors of a video camera;

Figure 9 **is** a graphic presentation for measuring a pilot cut;

Figure 10 **is** a graphic presentation for measuring a web width;\

Figure 11 **shows schematically** an electronic engraving machine for engraving printing forms with a second exemplary embodiment for the arrangement of a measuring instruments for measuring engraved sample cups~~, shown schematically~~;

Figure 12 **shows** the method sequence given an engraving machine; and

Figure 13 **shows** the method sequence given an engraving machine working in twin mode.

<u>DESCRIPTION OF THE PREFERRED EMBODIMENTS</u>

Figure 1 schematically shows an electronic engraving machine for engraving printing forms for rotogravure with a first exemplary embodiment for a measuring instrument for measuring sample cups generated in a sample engraving. For example, the engraving machine is a HelioKlischograph® of Hell Gravure Systems GmbH, Kiel, Germany.

A printing cylinder (10 is rotationally driven by a cylinder drive ~~(2)~~ **2**. The engraving on the printing cylinder ~~(1) ensues~~ **1 occurs** with an engraving element ~~(3)~~ **3** having an engraving stylus ~~(4)~~ **4** as cutting tool. The engraving element ~~(3)~~ **3** is located on an engraving carriage ~~(5)~~ **5** that can be moved in axial direction of the printing cylinder ~~(1)~~ **1** by an engraving carriage drive ~~(7)~~ **7** on the basis of a spindle ~~(6)~~ **6**.

The engraving stylus ~~(4)~~ **4** cuts a sequence of cups arranged in an engraving raster into the generated surface of the rotating printing cylinder ~~(1)~~ **1**

engraving line by engraving line while the engraving carriage ~~(5)~~ **5** with the engraving element ~~(3)~~ **3** moves along the printing cylinder ~~(1)~~ **1** in **the** axial direction.

The engraving stylus ~~(4)~~ **4** is controlled by an engraving control signal ~~(GS)~~ **GS**. The engraving control signal ~~(GS)~~ **GS** is formed in an engraving amplifier ~~(8)~~ **8** by superimposition of a periodic raster signal ~~(R)~~ **R** with image signal values ~~(B)~~ **B** that represent the hues of the cups to be engraved between "light" and "dark". Whereas the periodic raster signal ~~(R)~~ **R** effects a vibrating lifting motion of the engraving stylus ~~(4)~~ **4** for generating the engraving raster, the image signal values ~~(B)~~ **B** corresponding to the hues to be engraved determine the geometry values of the engraved cups.

The analog image signal values ~~(B)~~ **B** are acquired in a D/A converter ~~(9)~~ **9** from engraving data ~~(GD)~~ **GD** that are deposited in an engraving data memory ~~(10)~~ **10** and read therefrom engraving line by engraving line and supplied to the D/A converter ~~(9)~~ **9**. Each engraving location in the engraving raster has an engraving datum ~~(GD)~~ **GD** of at least one byte allocated to it that, as engraving information, contains the hue between "light" and "dark" to be engraved.

The generated surface of the printing cylinder ~~(1)~~ **1** has an engraving coordinate system allocated to it whose abscissa axis ~~ir~~ **is** oriented in axial direction of the printing cylinder ~~(1)~~ **1** (feed direction of the engraving element) and whose ordinate axis is oriented in circumferential direction of the printing cylinder ~~(1)~~ **1** (direction of the engraving lines). The engraving coordinates x_G and y_G of the engraving coordinate system define the engraving locations for the cups on the printing cylinder ~~(1)~~ **1**. The engraving carriage drive ~~(7)~~ **7** generates the engraving coordinates x_G that determine the axial positions of the engraving lines on the printing cylinder ~~(1)~~ **1**. A position sensor ~~(11)~~ **11** mechanically coupled to the cylinder drive ~~(2)~~ **2** generates the corresponding engraving coordinates y_G that indicate the relative circumferential positions of the rotating printing cylinder ~~(1)~~ **1** relative to the

engraving stylus ~~(4)~~ **4**. The engraving coordinates x_G and y_G of the engraving locations are supplied to a controller ~~(14)~~ **14** via lines ~~(12, 13)~~ **12, 13**.

The controller ~~(14)~~ **14** controls the addressing and the readout of the engraving data ~~(GD)~~ **GD** from the engraving data memory ~~(10)~~ **10** dependent on the engraving coordinates x_G and y_G of the current engraving locations via a line ~~(15).~~ **15.** The controller ~~(14)~~ **14** also generates the raster signal ~~(R)~~ **R** on a line ~~(16)~~ **16** with the frequency required for generating the engraving raster. For axial positioning of the engraving element ~~(3)~~ **3** relative to the printing cylinder ~~(1)~~ **1** and for controlling the feed motion of the engraving element ~~(3)~~ **3** during engraving, corresponding control commands ~~(S1)~~ **S_1** on a line ~~(17)~~ **17** to the engraving carriage drive ~~(7)~~ **7** are generated in the controller ~~(14)~~ 14. Further control commands ~~(S2)~~ **S_2** on a line ~~(18)~~ **18** control the cylinder drive ~~(2)~~ **2**.

For engraving sample cups ~~(19)~~ **19** on juxtaposed engraving lines ~~(21)~~ **21** in a sample engraving region ~~(20)~~ **20** of the printing cylinder ~~(1)~~ **1** that is not used for the later engraving, the engraving machine comprises a sample engraving computer ~~(22)~~ **22** that supplies the required engraving data ~~(GD*)~~ **GD*** to the D/A converter ~~(9)~~ **9**.

For measuring the geometry values of the sample cups ~~(19)~~ **19** generated in the sample engraving, a measuring carriage ~~(23)~~ **23** displaceable in **the** axial direction of the printing cylinder ~~(1)~~ **1** and having a video camera ~~(24)~~ **24** for recording a video image of the sample cups ~~(19)~~ **19**, an image evaluation unit ~~(26)~~ **26** connected to the video camera ~~(24)~~ **24** via a line ~~(25)~~ **25** for measuring the registered sample cups ~~(19)~~ **19** and a control monitor ~~(27)~~ **27** for monitoring the video image are present in the first exemplary embodiment shown in Figure 1.

The geometry values of the sample cups to be measured can, for example, be the transverse diagonals, the longitudinal diagonals, the widths of the pilot cuts and the web widths.

The video image of the sample cups ~~(19)~~ **19** can be made given a stationary printing cylinder ~~(1)~~ **1** or during the rotation of the printing cylinder ~~(1)~~ **1**, given a corresponding synchronization. The measuring carriage ~~(23)~~ **23** with the video camera ~~(24)~~ **24** can be axially positioned onto the sample cups ~~(19)~~ **19** generated in the sample engraving region, being positioned with a spindle ~~(28)~~ **28** and a measuring carriage drive ~~(29)~~ **29**. The measuring carriage drive ~~(29)~~ **29** is controlled by the controller (140 by control commands ~~(S3)~~ **S_3** on a line ~~(30)~~ **30**.

The geometry values of the sample cups ~~(19)~~ **19** measured in the image evaluation unit ~~(26)~~ **26** on the basis of the video image are transmitted to the sample engraving computer ~~(22)~~ **22** via a line ~~(31)~~ **31**. Setting values for calibrating the engraving amplifier ~~(8)~~ **8** are acquired in the sample engraving computer ~~(22)~~ **22** by comparing the measured, actual geometry values to the predetermined, rated geometry values. The engraving control signal ~~(GS)~~ **GS** in the engraving amplifier ~~(8)~~ **8** is then calibrated such with the setting values, which are supplied to the engraving amplifier ~~(8)~~ **8** via a line ~~(32)~~ **32**, that the cups actually generated in the later engraving of the printing cylinder ~~(1)~~ **1** correspond to the cups required for an engraving with correct hues.

The calibration of the engraving control signal ~~(GS)~~ **GS** can ~~ensue~~ **occur** automatically before the engraving or online during the engraving. The calibration, however, can also be manually implemented in that the sample engraving computer ~~(22)~~ **22** merely displays the setting values that have been determined, these then being manually transferred to the engraving amplifier ~~(8)~~ **8**.

The generation and evaluation of a sample engraving sequences according to the following method steps:

In a method step **[A]** for the implementation of the sample engraving, the engraving element ~~(3)~~ **3** with the engraving carriage ~~(5)~~ **5** is axially displaced from a zero position onto a rated position at which the first engraving line ~~(21')~~ **21'** is to be engraved within the sample engraving region ~~(20)~~ **20** provided for the sample

engraving, being manually or automatically displaced with the engraving carriage drive ~~(7)~~ **7**.

In a method step **[B]**, the sample engraving computer ~~(22)~~ **22** calls, for example, the engraving data ~~(GD*)~~ **GD*** for the rated hues "dark", "light" and for at least one "mid-hue" between "light" and "dark" for engraving the sample cups ~~(19)~~ **19**. The engraving data ~~(GD*)~~ **GD*** that have been called are converted into the engraving control signal ~~(GS)~~ **GS** for the engraving element ~~(3)~~ **3**. Proceeding from the first engraving line ~~(21')~~ **21'**, the engraving element ~~(3)~~ **3** respectively engraves at least one sample cup ~~(19)~~ **19** for "light", "dark" and "mid-hue" on juxtaposed engraving lines ~~(21)~~ **21**. A plurality of sample cups ~~(19)~~ **19** of the same hue are preferably engraved in circumferential direction on each engraving line ~~(21, 21')~~ **21, 21'** within the expanse of the sample engraving region ~~(20)~~ **20**.

In a method step **[C]**, the video camera ~~(24)~~ **24** with the measuring carriage ~~(23)~~ **23** is manually or automatically displaced with the measuring carriage drive ~~(29)~~ **29** from a zero position onto a predetermined measuring position that corresponds to the rated position of that engraving line ~~(21)~~ **21** whose sample cups ~~(19)~~ **19** are to be measured, for example onto the rated position of the first engraving line ~~(21')~~ **21'**, being displaced for measuring the geometry values of the engraved sample cups ~~(19)~~ **19**.

Let the video camera ~~(24)~~ **24** be adjusted such that, given coincidence of **the** measuring position and **the** rated position of an engraving line ~~(21)~~ **21**, the sample cups ~~(19)~~ **19** of this engraving line to be measured lie on a reference location in the middle of the video image, for example on the ordinate axis of a measurement coordinate system with the coordinate origin in the middle of the image. It is thereby assured that the sample cups ~~(19)~~ **19** are fully covered by the video camera ~~(24)~~ **24** given optimum image resolution in order to achieve a high measuring precision.

In practice, however, the engraving stylus ~~(4)~~ **4** must be occasionally replaced. Without involved readjustment, the original engraving stylus position can

be lost when changing engraving styli, and the sample cups ~~(19)~~ **19** are engraved at engraving locations that deviate from the rated engraving locations defined by the engraving coordinate values x_G and y_G. In this case, the sample cups ~~(19)~~ **19** are engraved on engraving lines ~~(21, 21')~~ **21, 21'** whose axial actual positions are offset compared to the predetermined rated positions. Given displacement of the video camera ~~(24)~~ **24** onto a predetermined measuring position that coincides with a predetermined rated position of an engraving line ~~(21, 21')~~ **21, 21'**, positive and negative position errors Δx_M and Δy_M of the sample cups ~~(19)~~ **19** engraved on the offset engraving line ~~(21, 21')~~ **21, 21'** compared to the measurement coordinate system therefore appear in the video image. Due to these position errors Δx_M and Δy_M, it can therefore occur that the sample cups ~~(19)~~ **19** do not fully lie in the video image given optimum image resolution, and imprecisions in the measurement of the geometry values of the sample cups are the result.

In order to improve the measuring precision, it is therefore proposed that one of the engraved sample cups ~~(19)~~ **19** be selected, the position errors Δx_M and Δy_M of the selected sample cup ~~be~~ **being** measured in a method step **[D]** as coordinate-related distances of a measuring location of the sample cup from a reference location in the video image, for example relative to the coordinate origin of the measurement coordinate system, and the identified position errors Δx_M and Δy_M ~~be~~ **are** corrected such before measuring the geometry values of at least the selected sample cup in a method step **[E]** by displacing the video camera ~~(24)~~ **24** onto a new measuring position and/or by turning the printing cylinder ~~(1)~~ **1 such** that the measuring location of the selected sample cup ~~(19')~~ **19'** lies in the reference location of the video image.

In the method step **[D]**, the position errors Δx_M and Δy_M of the measuring location of the selected sample cup ~~(19')~~ **19'** that have arisen in the positioning of the video camera ~~(24)~~ **24** to a predetermined measuring position are first measured

relative to the coordinate origin of the measurement coordinate system in the image evaluation unit ~~(26)~~ **26** on the basis of the registered video image.

For example, a sample cup ~~(19)~~ **19** that represents a "mid-hue" ~~(M)~~ **M** or, on the other hand, some other sample cup ~~(19)~~ **19** as well should therefore be selected as sample cup ~~(19')~~ **19'** whose measuring location is to be shifted into the coordinate origin of the measurement coordinate system. Dependent on which geometry values are to be determined, the mid-point of the cup area, the mid-point of the transverse diagonals or longitudinal diagonals of the sample cup or, on the other hand, the mid-point of a web or pilot cut to be measured should be defined as **a** measuring location of the selected sample cup ~~(19')~~ **19'**. The measurement of the position errors Δx_M and Δy_M of the selected sample cup in the video image is explained on the basis of Figure 2.

Figure 2 shows a registered video image ~~(35)~~ **35** of the engraved sample cups ~~(19)~~ **19** with the orthogonal engraving raster composed of horizontal and vertical raster lines, whereby the vertical raster lines are the engraving lines ~~(21)~~ **21**. For example, engraved sample cups ~~(19)~~ **19** for "light" ~~(L)~~ **L**, "dark" ~~(T)~~ **T** and "mid-hue" ~~(M)~~ **M** are shown on three juxtaposed engraving lines ~~(21)~~ **21**. The centers of gravity of the sample cups ~~(19)~~ **19** lie on the intersections of the raster lines of the engraving raster.

The video image ~~(35)~~ **35** is composed of a plurality of pixels ~~(36)~~ **36** whose positions in the video image ~~(35)~~ **35** are defined by the image coordinates x_V and y_V of an image coordinate system ~~(37)~~ **37** allocated to the video image ~~(35)~~ **35**. The coordinate axes of the image coordinate system ~~(37)~~ **37** is directed in **the** longitudinal and **the** transverse expanse of the video image ~~(35)~~ **35**, and the coordinate origin ~~(36)~~ **36** lies in a corner point of the video image ~~(35)~~ **35**. The coordinate axes of the measurement coordinate system ~~(4)~~ **4** are aligned parallel to the coordinate axes of the image coordinate system ~~(37)~~ **37**. The coordinate origin ~~(39)~~ **39** of the measurement coordinate system ~~(40)~~ **40**, which lies in the mid-point of the

video image ~~(35)~~ **35** has the image coordinates x_{VM} and y_{VM} in the image coordinate system ~~(37)~~ **37**. The following coordinate-related relationship thus derives:

$$x_M = x_V - x_{VM}$$

$$y_M = y_V - y_{VM}$$

For example, the sample cup ~~(19')~~ **19'** with the mid-point of the cup area as measuring location ~~(41)~~ **41** that has the image coordinates x_{VB} and y_{VB} in the image coordinate system ~~(37)~~ **37** is selected. The position errors Δx_M and Δy_M of the selected sample cup ~~(19')~~ **19'** in the measurement coordinate system ~~(40)~~ **40** thus derive as:

$$\Delta x_M = x_{VB} - x_{VM}$$

$$\Delta y_M = y_{VB} - y_{VM}$$

Every pixel ~~(36)~~ **36** has a video datum ~~(VD)~~ **VD** of, for example, 8 bits characterizing the respective gray scale value allocated to it, so that a total of 254 gray scale values can be distinguished between "black" ~~(VD=0)~~ **VD=0** and "white" ~~(VD=255)~~ **VD=255**. By filtering or with thresholds, the gray scale values can be reduced such to two values that, for example, the video datum VD = 0 is allocated to those pixels that fall onto the generated surface of the printing cylinder ~~(1)~~ **1** and the video datum VD = 1 is allocated to those pixels that fall onto the cup areas of the sample cup ~~(19)~~ **19**. The contour (density discontinuity) of a cup area is thereby characterized by the change of the video datum from "0" to "1" or from "1" to "0".

For automatically determining the image coordinate values x_{VB} and y_{VB} of the measuring location ~~(41)~~ **41** of the selected sample cup ~~(19')~~ **19'** in the image coordinate system ~~(37),~~ **37,** for example~~,~~ a stripe-shaped measurement field ~~(42)~~ **42** is defined that can be shifted across the video image and that can be aligned with an arbitrary orientation in the image coordinate system ~~(37)~~ **37**.

The measurement field ~~(42)~~ **42** is composed of at least one measurement line ~~(43)~~ **43**, preferably of a plurality of measurement lines ~~(43)~~ **43** proceeding parallel to one another, and each measurement line ~~(43)~~ **43** comprises a plurality of pixels ~~(36)~~ **36** whose position in the image coordinate system ~~(37)~~ **37** is respectively defined by

an image coordinate pair x_{VMP} and y_{VMP}, so that the position in the image coordinate system ~~(37)~~ **37** can also be determined for each pixel ~~(36)~~ **36** within the measurement lines ~~(43)~~ **43**. The longitudinal expanse of the measurement field ~~(42)~~ **42** amounts to at least the same as the spacing of two engraving lines ~~(21)~~ **21**. The spacings of the pixels ~~(36)~~ **36** from one another respectively represent a length increment. By counting the pixels ~~(36)~~ **36** within a measurement distance ~~(44)~~ **44**, the length of the measurement distance ~~(44)~~ **44** can thus be measured as a multiple of the length increment.

Figure 3 shows the formation of a stripe-shaped measurement field ~~(42)~~ **42** that, for example, is composed of ~~a~~ measurement lines ~~[sic]~~ ~~(43)~~ **43** with fourteen pixels ~~(36)~~ **36**.

Figure 4 shows the formation of a quadratic measurement field ~~(42)~~ **42** that, for example, is composed of 6 measurement lines ~~(43)~~ **43** with respectively 6 pixels ~~(36)~~ **36** in each measurement line ~~(43)~~ **43**.

As already explained, the edges of the cup area of a sample cup ~~(19)~~ **19** in the registered video image ~~(35)~~ **35** form a contour ~~(45)~~ **45**. The measurement distance ~~(44)~~ **44**, for example for measuring the maximum transverse diagonal or the maximum longitudinal diagonal of the sample cup ~~(19)~~ **19**, thus derives from the respective spacing of the corresponding contours ~~(45)~~ **45** from one another.

The end pixels ~~(36', 36")~~ **36', 36"** of the measurement distance ~~(44)~~ **44** are advantageously determined with the assistance of the measurement field ~~(42)~~ **42** itself on the basis of an automatic recognition of two neighboring contours ~~(45)~~ **45**, in that the respective video data ~~(VD)~~ **VD** of two successive pixels ~~(36)~~ **36** of the measurement line ~~(43)~~ **43** are investigated for a change of the video data ~~(VD)~~ **VD**.

Figure 5 shows the measurement band ~~(42)~~ **42** with one measurement line ~~(43)~~ **43** and two contours ~~(45)~~ **45** spaced from one another. The video data ~~(VD)~~ **VD** allocated to the individual pixels ~~(36)~~ **36** are also shown, whereby the contours ~~(45)~~ **45** are characterized by the change "0' to "1" and "1" to "0". The corresponding end

pixels ~~(36', 36")~~ **36', 36"** of the measurement distance ~~(44)~~ **44**, which is composed of 9 pixels ~~(36)~~ **36** in the illustrated case, are determined by an automatic contour recognition.

Figure 6 shows the measurement of the image coordinate value x_{VB} of the measurement location ~~(41)~~ **41** of the selected sample cup ~~(19')~~ **19'** with the stripe-shaped measurement field ~~(42)~~ **42**, which is composed of one measurement line ~~(43)~~ **43**. In the illustrated example, the measurement location ~~(41)~~ **41** is the mid-point of the cup area of the selected sample cup ~~(19')~~ **19'**. The measurement field ~~(42)~~ **42** has its longitudinal expanse aligned in the direction of the abscissa of the image coordinate system ~~(37)~~ **37** and is shifted onto the selected sample cup ~~(19')~~ **19'**. The end pixels ~~(36', 36")~~ **36', 36"** of the measurement distance ~~(44)~~ **44** are determined by the automatic recognition of the contour ~~(45)~~ **45** of the cup area of the selected sample cup ~~(19')~~ **19'**. The plurality of pixels ~~(36)~~ **36** that devolve onto the measurement distance ~~(44)~~ **44** is thus known, and the middle pixel (360 of the measurement distance (440 then represents the measurement location ~~(41)~~ **41** of the selected sample cup ~~(19')~~ **19'**. The image coordinate value x_{VB} of the measurement location ~~(41)~~ **41** of the selected sample cup ~~(19')~~ **19'** in the image coordinate system ~~(37)~~ **37** then derives as **a** coordinate value of the middle pixel of the measurement distance ~~(44)~~ **44**.

Figure 7 shows the corresponding measurement of the image coordinate value y_{VB} of the measurement location ~~(41)~~ **41** of the selected sample cup ~~(19')~~ **19'** with the measurement field ~~(42)~~ **42** that has its longitudinal expanse aligned in the direction of the ordinate of the image coordinate system ~~(37)~~ **37** for this purpose. In the illustrated example, the measurement location ~~(41)~~ **41** is again the mid-point of the cup area. The image coordinate value y_{VB} of the measurement location ~~(41)~~ **41** of the selected sample cup ~~(19')~~ **19'** then derives from the identified coordinate value of the middle pixel ~~(36)~~ **36** of the measurement distance ~~(44)~~ **44**.

Advantageously, the selected sample cup ~~(19')~~ **19'** that represents a defined hue is automatically "sought" in the video image ~~(35)~~ **35** with the assistance

of a measurement field ~~(42)~~ **42** composed of a plurality of measurement lines ~~(43). To~~ **43. For** that ~~end~~ **purpose,** the cup area of the sample cup ~~(19')~~ **19'** is prescribed according to the predetermined hue as a plurality of pixels ~~(36)~~ **36**. A corresponding measurement field is shown in Figure 4. The size of the measurement field ~~(42)~~ **42** at least corresponds to the size of the predetermined cup area, so that all pixels ~~(36)~~ **36** falling into the cup area can be covered by the measurement field ~~(42)~~ **42**. The measurement field ~~(42)~~ **42** is shifted across the video image ~~(35)~~ **35** from engraving location to engraving location of the sample cups ~~(19)~~ **19**. At every engraving location, the cup area of the ~~appertaining~~ **corresponding** sample cup ~~(19)~~ **19** is measured with the assistance of the measurement field ~~(42)~~ **42** in that the pixels ~~(36)~~ **36** counted in the individual measurement lines ~~(43)~~ **43** are added up and compared to the pixel plurality of the predetermined cup area. A sample cup ~~(19)~~ **19** has been identified as selected sample cup ~~(19')~~ **19'** when the predetermined and the measured cup area agree.

In a method step **[E]**, the measured position errors Δx_M and Δy_M are compensated by displacing the measurement carriage ~~(23)~~ **23** and/or by turning the printing cylinder ~~(1)~~ **1**. The compensation can ensue manually under visual control of the video image on the control monitor ~~(27)~~ **27** or with an automatic control of cylinder drive ~~(2)~~ **2** and/or engraving carriage drive ~~(7)~~ **7** via the controller ~~(14)~~ **14.** The image evaluation unit ~~(23)~~ **23** thereby supplies a corresponding control command ~~(S4)~~ S_4 to the controller ~~(14)~~ **14** via a line ~~(33)~~ **33** when the evaluation of the video image has yielded that the measurement location ~~(41)~~ **41** of the selected sample cup ~~(19')~~ **19'** is congruent with the coordinate origin ~~(38)~~ **38** of the measurement coordinate system ~~(40)~~ **40**, as a result whereof an exact determination of the geometry values of the engraved sample cups ~~(19)~~ **19** is assured.

Figure 8 shows the video image ~~(35)~~ **35** after the correction of the position errors Δx_M and Δy_M. The measurement location ~~(41)~~ **41** of the selected sample cup

~~(19')~~ **19'** is now congruent with the coordinate origin ~~(38)~~ **38** of the measurement coordinate system ~~(40)~~ **40** in the video image ~~(35)~~ **35**.

In most instances, it suffices to merely compensate the axial position error Δx_M by shifting the measurement carriage ~~(23)~~ **23** since a plurality of sample cups ~~(19)~~ **19** for a hue are usually engraved in engraving line direction and, thus, at least one sample cup ~~(19)~~ **19** of a hue lies in the pickup area of the video camera ~~(24)~~ **24**.

After compensation of the position errors Δx_M and Δy_M, the determination of the geometry values of the engraved sample cups ~~(19) ensues~~ **19 occurs** in a method step **[F]** with an automatic evaluation in the image evaluation unit ~~(26)~~ **26** of the video image ~~(35)~~ **35** according to Figure 8 registered with the video camera ~~(24)~~ **24**. The measurement is advantageously implemented with the assistance of the same measurement field ~~(42)~~ **42** that was already employed for the measurement of the position errors Δx_M and Δy_M.

For measuring the maximum transverse diagonal ~~(dQmax)~~ $\mathbf{d}_{\mathbf{Qmax}}$, which corresponds to the measurement distance ~~(44)~~ **44** in Figure 6, or an arbitrary transverse diagonal ~~(dQ)~~ $\mathbf{d}_{\mathbf{Q}}$ of a sample cup ~~(19)~~ **19**, the measurement field – as already shown in Figure 6 – has its longitudinal expanse aligned in the direction of the abscissa of the measurement coordinate system ~~(40)~~ **40**.

For measuring the maximum longitudinal diagonal ~~(dLmax)~~ $\mathbf{d}_{\mathbf{Lmax}}$, which corresponds to the measurement distance in Figure 7, or an arbitrary longitudinal diagonal ~~(dL)~~ $\mathbf{d}_{\mathbf{L}}$ of a sample cup ~~(19)~~ **19**, the measurement field ~~(42)~~ **42** – as shown in Figure 7 – has its longitudinal expanse aligned in the direction of the ordinate of the measurement coordinate system ~~(40)~~ **40**.

For measuring the pilot cut ~~(dDS)~~ $\mathbf{d}_{\mathbf{DS}}$, i.e. the width of the engraving channel in the direction of the abscissa of the measurement coordinate system ~~(40)~~ **40** that connects two sample cups ~~(19)~~ **19** engraved on an engraving line ~~(21)~~ **21**, the measurement field ~~(42)~~ **42** again has its longitudinal expanse aligned in the direction

of the abscissa. The measurement of the pilot cut ~~(dDS)~~ **d_{DS}** is graphically shown in Figure 9.

For measuring the web width ~~(dSB)~~ **d_{SB}**, i.e. the width of the material that has remained standing between two deep cups engraved on neighboring engraving lines ~~(21, 21')~~ **21, 21'**, the measurement field is expediently turned such that it has its longitudinal expanse aligned approximately perpendicularly to the course of the web. The measurement of the web width ~~(dSB)~~ **d_{SB}** is graphically shown in Figure 10.

Figure 11 schematically shows an electronic engraving machine for engraving printing forms with a second exemplary embodiment for a measuring device for measuring engraved sample cups ~~(19)~~ **19**.

In this exemplary embodiment, the video camera ~~(24)~~ **24** – differing from what is shown in Figure 1 – is not arranged on a separate measurement carriage ~~(23)~~ **23** but on the engraving carriage ~~(7)~~ **7** next to the engraving element ~~(3)~~ **3** with a structurally conditioned axial spacing B from the engraving stylus ~~(4)~~ **4** of the engraving element ~~(3)~~ **3**. The video image ~~(35)~~ **35** of the engraved sample cups ~~(19)~~ **19** is picked up, for example, via a lightguide cable whose light entry face is arranged in a plane proceeding perpendicular to the axial direction and through the tip of the engraving stylus ~~(4)~~ **4** of the engraving element ~~(3)~~ **3**. Alternatively thereto, the video image ~~(35)~~ **35** of the engraved sample cups ~~(19)~~ **19** can also be directly registered with the video camera ~~(24)~~ **24**. In this case, the video camera ~~(24)~~ **24** mounted on the engraving carriage ~~(5)~~ **5** is first shifted by the axial distance B onto the predetermined measurement position in the sample engraving region ~~(20)~~ **20** with the engraving carriage drive ~~(7)~~ **7** after engraving the sample cups ~~(19)~~ **19**. Subsequently, the position errors Δx_M and Δy_M are measured and corrected and the engraved sample cups ~~(19)~~ **19** are measured.

Figure 12, in summary, schematically shows the work execution at an engraving machine, whereby it is assumed that the video camera ~~(24)~~ **24** is mounted

next to the engraving element ~~(3)~~ **3** on the engraving carriage ~~(5)~~ **5** according to the exemplary embodiment according to Figure 11.

a) Displacing the engraving element ~~(3)~~ **3** with the engraving carriage ~~(5)~~ **5** onto a predetermined, axial rated position ~~(47)~~ **47** of an engraving line ~~(21)~~ **21** to be engraved and engraving of sample cups ~~(19)~~ **19** on an engraving line ~~(21)~~ **21** in an axial actual position ~~(48)~~ **48** that, due to an axial position error Δx, deviates from the rated position ~~(47)~~ **47**, according to method steps **[A]** and **[B]**.

b) Positioning the video camera ~~(24)~~ **24** to the predetermined measurement position ~~(47)~~ **47**, which coincides with the predetermined rated position ~~(47)~~ **47** of the engraving line ~~(21)~~ **21**, by displacing the engraving carriage ~~(5)~~ **5** according to method step **[C]**.

c) Measuring the position error Δx of the video camera ~~(24)~~ **24** in the predetermined measurement position ~~(47)~~ **47** according to method step **[D]**.

d) Correction of the position error Δx of the video camera ~~(24)~~ **24** by displacing the engraving carriage ~~(5)~~ **5** into a new measurement position ~~(48)~~ **48** according to method step **[E]** and

e) measuring the engraved sample cups ~~(19)~~ **19** that were engraved on the engraving line ~~(21)~~ **21** in the actual position ~~(48)~~ **48** at the new measurement position ~~(48)~~ **48** of the video camera ~~(24)~~ **24** according to method step **[F]**.

The method can preferably also be utilized in the engraving of a plurality of engraving lanes lying juxtaposed in axial direction on a printing cylinder with a respectively allocated engraving element and in what is referred to as the twin mode of the engraving machine.

When engraving a plurality of engraving lanes on a printing cylinder ~~(1)~~ **1** with a respectively allocated engraving element ~~(3)~~ **3**, a separate sample engraving must be implemented for each engraving element ~~(3)~~ **3**. For measuring the sample engravings, let the engraving machine be equipped with the displaceable measurement carriage ~~(23)~~ **23** with the video camera ~~(24)~~ **24** according to the exemplary embodiment of Figure 1. For measuring the individual sample engravings in each engraving lane, the video camera ~~(24)~~ **24** is respectively axially displaced onto the individual measurement positions by the width of an engraving lane. In this case, the above-explained method steps **[A]** through **[F]** are implemented in every measurement position. Of course, a video camera according to the exemplary embodiment of Figure 11 can also be allocated to each engraving element ~~(3)~~ **3**.

In what is referred to as the twin mode of an engraving machine, two printing cylinders ~~(~~1, 1* ~~)~~ are mechanically coupled to one another, these being engraved with a respective engraving element ~~(~~3, 3*~~)~~. The engraving element ~~(~~3, 3* ~~)~~ are mounted on the shared engraving carriage ~~(5)~~ **5** with a fixed spacing from one another, said engraving carriage ~~(5)~~ **5** moving axially along both printing cylinders ~~(~~1, 1*~~)~~. A sampling engraving is engraved on the appertaining printing cylinder ~~(~~1, 1* ~~)~~ with each engraving element ~~(~~3, 3*~~)~~. For measuring the sample engravings, let the engraving element ~~(~~3, 3* ~~)~~ comprise a video camera ~~(~~24, 24* ~~)~~ on the engraving carriage ~~(5)~~ **5** next to each engraving element ~~(~~3, 3* ~~)~~ according to the exemplary embodiment of Figure 11. A modified work sequence derives in this case.

Figure 13 schematically shows the modified work sequence at an engraving machine working in twin mode, whereby it is assumed that a respective video camera ~~(~~24, 24* ~~)~~ is mounted on the shared engraving carriage ~~(5)~~ **5** next to the engraving element ~~(~~3, 3* ~~)~~ according to the exemplary embodiment of Figure 11.

a) Displacing the engraving elements ~~(~~3, 3* ~~)~~ with the shared engraving carriage ~~(5)~~ **5** onto predetermined, axial rated position ~~(~~47, 47* ~~)~~ of

engraving lines ~~(~~21, 21* ~~)~~ to be engraved and engraving sample cups ~~(~~19, 19* ~~)~~ on the engraving lines ~~(~~21, 21* ~~)~~ in axial actual positions ~~(~~48, 48* ~~)~~ that deviate from the rated positions ~~(~~47, 47* ~~)~~ due to axial position errors Δx and Δx^*, according to method steps **[A]** and **[B]**.

b) Positioning the first video camera ~~(24)~~ **24** to a predetermined, first measurement position ~~(47)~~ **47** that coincides with the predetermined, first rated position ~~(47)~~ **47** of an engraving line ~~(21)~~ **21** by displacing the shared engraving carriage ~~(5)~~ **5** according to method step **[C]**.

c) Measuring the position error Δx of the first video camera ~~(24)~~ **24** in the predetermined, first measurement position ~~(47)~~ **47** according to method step **[D]**.

d) Correcting the measured position error Δx of the first video camera ~~(24)~~ **24** by displacing the shared engraving carriage ~~(5)~~ **5** into a new first measurement position ~~(48)~~ **48** according to method step **[E]**.

e) Measuring the geometry values of the sample cups ~~(19)~~ **19** engraved on the first printing cylinder ~~(1)~~ **1** that were engraved on the engraving line ~~(21)~~ **21** in the first actual position ~~(48)~~ **48** at the new, first measurement position ~~(50)~~ **50** of the first video camera ~~(~~240 according to method step **[F]**.

f) Measuring the position error Δx^* of the second video camera ~~(24*)~~ **24*** in the momentary position of the shared engraving carriage ~~(5)~~ **5** according to method step **[D]**.

g) Calculating a new position error Δx^*_{new} for the second video camera ~~(24*)~~ **24***.

h) Correcting the calculated position error Δx^*_{new} of the second video camera ~~(24*)~~ **24*** into a new, second measurement position ~~(48*)~~ **48*** by displacing the shared engraving carriage ~~(5)~~ **5** according to method step **[E]**, and

i) measuring the geometry values of the sample cups ~~(19)~~ **19** engraved on the second printing cylinder ~~(1*)~~ **1*** that were engraved on the engraving line ~~(21*)~~ **21*** in the second actual position ~~(48*)~~ **48*** at the new, second measurement position ~~(50*)~~ **50*** of the second video camera ~~(24*)~~ **24*** according to method step **[F]**.

Although only a preferred embodiment has been shown, other related embodiments may be suggested by those skilled in the art. Also, various minor modifications might be suggested by those skilled in the art, and it should be understood that it is my wish to embody within the scope of the patent warranted hereon all such other embodiments and modifications as reasonably and properly come within the scope of my contribution to the art.

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METHOD FOR GENERATING AND EVALUATING A SAMPLE ENGRAVING

The invention is in the field of electronic reproduction technology and is directed to a method for generating and evaluating a sample engraving in an electronic engraving machine for engraving printing cylinders for rotogravure.

In an electronic engraving machine, an engraving element with an engraving stylus as cutting tool moves in axial direction along a rotating printing cylinder. The engraving stylus controlled by an engraving control signal cuts a sequence of cups arranged in an engraving raster into the generated surface of the printing cylinder. The engraving control signal is formed by superimposition of image signal values, which represent the hues to be engraved between "light" (white) and "dark" (black), with a periodic raster signal. Whereas the raster signal effects an vibrating lifting motion of the engraving stylus for generating the engraving raster, the image signal values determine the geometry values of the cups engraved into the printing cylinder.

The engraving control signal must be calibrated so that the engraved hues correspond to the hues defined by the image signal values. To that end, what is referred to as a sample engraving is implemented before the actual engraving, sample cups for predetermined hues being engraved into the printing cylinder in this sample engraving.

After the sample engraving, a measuring instrument is positioned on the engraved sample cups and their geometry values such as, for example, the transverse diagonals and longitudinal diagonals are measured.

The measured geometry values of the sample cups are then compared to the predetermined geometry values. Setting values are obtained from the comparison with which the engraving control signal is calibrated such that the geometry values of the cups generated in the later engraving coincide with the geometry values required for reproduction with proper hues.

The PCT patent application serial number PCT/DE 98/01441 has already disclosed that a video camera with an image evaluation unit be employed for

determining the geometry values of engraved sample cups, the geometry values in a video image of the sample cups registered with the video camera being measured with said image evaluation unit.

A prerequisite for an exact measurement is that the sample cups fall completely into the image excerpt registered by the video camera after a manual or automatic positioning of the video camera given optimum image resolution. This condition is not always met in practice, particularly after changing engraving styli, and mismeasurements are the result.

It is therefore an object of the present invention to improve a method for generating and evaluating a sample engraving in an electronic engraving machine for engraving printing cylinders for rotogravure with respect to the positioning of a measuring instrument, particularly a video camera, such that a high-precision, automatic measuring of the sample cups generated in the sample engraving is assured.

This object is achieved by the features of claim 1. Advantageous developments and improvements are recited in the subclaims.

The invention is explained in greater detail below on the basis of Figures 1 through 13.

Shown are:

Figure 1 an electronic engraving machine for engraving printing forms with a first exemplary embodiment for the arrangement of a measuring instruments for measuring engraved sample cups, shown schematically;

Figure 2 a video image of engraved sample cups before correction of positioning errors of a video camera;

Figure 3 the formation of a stripe-shaped measuring field;

Figure 4 the formation of a quadratic measuring field;

Figure 5 a graphic presentation for automatically determining a measuring distance within a measurement field;

Figure 6 a graphic presentation for measuring the positioning errors of a sample cup in one coordinate direction;

Figure 7 a graphic presentation for measuring the positioning errors of a sample cup in the other coordinate direction;

Figure 8 a video image of engraved sample cups after a correction of positioning errors of a video camera;

Figure 9 a graphic presentation for measuring a pilot cut;

Figure 10 a graphic presentation for measuring a web width;\

Figure 11 an electronic engraving machine for engraving printing forms with a second exemplary embodiment for the arrangement of a measuring instruments for measuring engraved sample cups, shown schematically;

Figure 12 the method sequence given an engraving machine; and

Figure 13 the method sequence given an engraving machine working in twin mode.

Figure 1 schematically shows an electronic engraving machine for engraving printing forms for rotogravure with a first exemplary embodiment for a measuring instrument for measuring sample cups generated in a sample engraving. For example, the engraving machine is a HelioKlischograph® of Hell Gravure Systems GmbH, Kiel, Germany.

A printing cylinder (10 is rotationally driven by a cylinder drive (2). The engraving on the printing cylinder (1) ensues with an engraving element (3) having an engraving stylus (4) as cutting tool. The engraving element (3) is located on an engraving carriage (5) that can be moved in axial direction of the printing cylinder (1) by an engraving carriage drive (7) on the basis of a spindle (6).

The engraving stylus (4) cuts a sequence of cups arranged in an engraving raster into the generated surface of the rotating printing cylinder (1) engraving line by engraving line while the engraving carriage (5) with the engraving element (3) moves along the printing cylinder (1) in axial direction.

The engraving stylus (4) is controlled by an engraving control signal (GS). The engraving control signal (GS) is formed in an engraving amplifier (8) by superimposition of a periodic raster signal (R) with image signal values (B) that represent the hues of the cups to be engraved between "light" and "dark". Whereas the periodic raster signal (R) effects a vibrating lifting motion of the engraving stylus (4) for generating the engraving raster, the image signal values (B) corresponding to the hues to be engraved determine the geometry values of the engraved cups.

The analog image signal values (B) are acquired in a D/A converter (9) from engraving data (GD) that are deposited in an engraving data memory (10) and read therefrom engraving line by engraving line and supplied to the D/A converter (9). Each engraving location in the engraving raster has an engraving datum (GD) of at least one byte allocated to it that, as engraving information, contains the hue between "light" and "dark" to be engraved.

The generated surface of the printing cylinder (1) has an engraving coordinate system allocated to it whose abscissa axis ir oriented in axial direction of the printing cylinder (1) (feed direction of the engraving element) and whose ordinate axis is oriented in circumferential direction of the printing cylinder (1) (direction of the engraving lines). The engraving coordinates x_G and y_G of the engraving coordinate system define the engraving locations for the cups on the printing cylinder (1). The engraving carriage drive (7) generates the engraving coordinates x_G that determine the axial positions of the engraving lines on the printing cylinder (1). A position sensor (11) mechanically coupled to the cylinder drive (2) generates the corresponding engraving coordinates y_G that indicate the relative circumferential positions of the rotating printing cylinder (1) relative to the engraving stylus (4). The engraving coordinates x_G and y_G of the engraving locations are supplied to a controller (14) via lines (12, 13).

The controller (14) controls the addressing and the readout of the engraving data (GD) from the engraving data memory (10) dependent on the engraving coordinates x_G and y_G of the current engraving locations via a line (15). The controller (14) also generates the raster signal (R) on a line (16) with the frequency required for generating the engraving raster. For axial positioning of the engraving element (3) relative to the printing cylinder (1) and for controlling the feed motion of the engraving element (3) during engraving, corresponding control commands (S_1) on a line (17) to the engraving carriage drive (7) are generated in the controller (14). Further control commands (S_2) on a line (18) control the cylinder drive (2).

For engraving sample cups (19) on juxtaposed engraving lines (21) in a sample engraving region (20) of the printing cylinder (1) that is not used for the later

engraving, the engraving machine comprises a sample engraving computer (22) that supplies the required engraving data (GD*) to the D/A converter (9).

For measuring the geometry values of the sample cups (19) generated in the sample engraving, a measuring carriage (23) displaceable in axial direction of the printing cylinder (1) and having a video camera (24) for recording a video image of the sample cups (19), an image evaluation unit (26) connected to the video camera (24) via a line (25) for measuring the registered sample cups (19) and a control monitor (27) for monitoring the video image are present in the first exemplary embodiment shown in Figure 1.

The geometry values of the sample cups to be measured can, for example, be the transverse diagonals, the longitudinal diagonals, the widths of the pilot cuts and the web widths.

The video image of the sample cups (19) can be made given a stationary printing cylinder (1) or during the rotation of the printing cylinder (1), given a corresponding synchronization. The measuring carriage (23) with the video camera (24) can be axially positioned onto the sample cups (19) generated in the sample engraving region, being positioned with a spindle (28) and a measuring carriage drive (29). The measuring carriage drive (29) is controlled by the controller (140 by control commands (S_3) on a line (30).

The geometry values of the sample cups (19) measured in the image evaluation unit (26) on the basis of the video image are transmitted to the sample engraving computer (22) via a line (31). Setting values for calibrating the engraving amplifier (8) are acquired in the sample engraving computer (22) by comparing the measured, actual geometry values to the predetermined, rated geometry values. The engraving control signal (GS) in the engraving amplifier (8) is then calibrated such with the setting values, which are supplied to the engraving amplifier (8) via a line (32), that the cups actually generated in the later engraving of the printing cylinder (1) correspond to the cups required for an engraving with correct hues.

The calibration of the engraving control signal (GS) can ensue automatically before the engraving or online during the engraving. The calibration, however, can also be manually implemented in that the sample engraving computer

(22) merely displays the setting values that have been determined, these then being manually transferred to the engraving amplifier (8).

The generation and evaluation of a sample engraving sequences according to the following method steps:

In a method step **[A]** for the implementation of the sample engraving, the engraving element (3) with the engraving carriage (5) is axially displaced from a zero position onto a rated position at which the first engraving line (21') is to be engraved within the sample engraving region (20) provided for the sample engraving, being manually or automatically displaced with the engraving carriage drive (7).

In a method step **[B]**, the sample engraving computer (22) calls, for example, the engraving data (GD*) for the rated hues "dark", "light" and for at least one "mid-hue" between "light" and "dark" for engraving the sample cups (19). The engraving data (GD*) that have been called are converted into the engraving control signal (GS) for the engraving element (3). Proceeding from the first engraving line (21'), the engraving element (3) respectively engraves at least one sample cup (19) for "light", "dark" and "mid-hue" on juxtaposed engraving lines (21). A plurality of sample cups (19) of the same hue are preferably engraved in circumferential direction on each engraving line (21, 21') within the expanse of the sample engraving region (20).

In a method step **[C]**, the video camera (24) with the measuring carriage (23) is manually or automatically displaced with the measuring carriage drive (29) from a zero position onto a predetermined measuring position that corresponds to the rated position of that engraving line (21) whose sample cups (19) are to be measured, for example onto the rated position of the first engraving line (21'), being displaced for measuring the geometry values of the engraved sample cups (19).

Let the video camera (24) be adjusted such that, given coincidence of measuring position and rated position of an engraving line (21), the sample cups (19) of this engraving line to be measured lie on a reference location in the middle of the video image, for example on the ordinate axis of a measurement coordinate system with the coordinate origin in the middle of the image. It is thereby assured that the

sample cups (19) are fully covered by the video camera (24) given optimum image resolution in order to achieve a high measuring precision.

In practice, however, the engraving stylus (4) must be occasionally replaced. Without involved readjustment, the original engraving stylus position can be lost when changing engraving styli, and the sample cups (19) are engraved at engraving locations that deviate from the rated engraving locations defined by the engraving coordinate values x_G and y_G. In this case, the sample cups (19) are engraved on engraving lines (21, 21') whose axial actual positions are offset compared to the predetermined rated positions. Given displacement of the video camera (24) onto a predetermined measuring position that coincides with a predetermined rated position of an engraving line (21, 21'), positive and negative position errors Δx_M and Δy_M of the sample cups (19) engraved on the offset engraving line (21, 21') compared to the measurement coordinate system therefore appear in the video image. Due to these position errors Δx_M and Δy_M, it can therefore occur that the sample cups (19) do not fully lie in the video image given optimum image resolution, and imprecisions in the measurement of the geometry values of the sample cups are the result.

In order to improve the measuring precision, it is therefore proposed that one of the engraved sample cups (19) be selected, the position errors Δx_M and Δy_M of the selected sample cup be measured in a method step **[D]** as coordinate-related distances of a measuring location of the sample cup from a reference location in the video image, for example relative to the coordinate origin of the measurement coordinate system, and the identified position errors Δx_M and Δy_M be corrected such before measuring the geometry values of at least the selected sample cup in a method step **[E]** by displacing the video camera (24) onto a new measuring position and/or by turning the printing cylinder (1) that the measuring location of the selected sample cup (19') lies in the reference location of the video image.

In the method step **[D]**, the position errors Δx_M and Δy_M of the measuring location of the selected sample cup (19') that have arisen in the positioning of the video camera (24) to a predetermined measuring position are first measured relative to the coordinate origin of the measurement coordinate system in the image evaluation unit (26) on the basis of the registered video image.

For example, a sample cup (19) that represents a "mid-hue" (M) or, on the other hand, some other sample cup (19) as well should therefore be selected as sample cup (19') whose measuring location is to be shifted into the coordinate origin of the measurement coordinate system. Dependent on which geometry values are to be determined, the mid-point of the cup area, the mid-point of the transverse diagonals or longitudinal diagonals of the sample cup or, on the other hand, the mid-point of a web or pilot cut to be measured should be defined as measuring location of the selected sample cup (19'). The measurement of the position errors Δx_M and Δy_M of the selected sample cup in the video image is explained on the basis of Figure 2.

Figure 2 shows a registered video image (35) of the engraved sample cups (19) with the orthogonal engraving raster composed of horizontal and vertical raster lines, whereby the vertical raster lines are the engraving lines (21). For example, engraved sample cups (19) for "light" (L), "dark" (T) and "mid-hue" (M) are shown on three juxtaposed engraving lines (21). The centers of gravity of the sample cups (19) lie on the intersections of the raster lines of the engraving raster.

The video image (35) is composed of a plurality of pixels (36) whose positions in the video image (35) are defined by the image coordinates x_V and y_V of an image coordinate system (37) allocated to the video image (35). The coordinate axes of the image coordinate system (37) is directed in longitudinal and transverse expanse of the video image (35), and the coordinate origin (36) lies in a corner point of the video image (35). The coordinate axes of the measurement coordinate system (4) are aligned parallel to the coordinate axes of the image coordinate system (37). The coordinate origin (39) of the measurement coordinate system (40), which lies in the mid-point of the video image (35) has the image coordinates x_{VM} and y_{VM} in the image coordinate system (37). The following coordinate-related relationship thus derives:

$$x_M = x_V - x_{VM}$$

$$y_M = y_V - y_{VM}$$

For example, the sample cup (19') with the mid-point of the cup area as measuring location (41) that has the image coordinates x_{VB} and y_{VB} in the image coordinate system (37) is selected. The position errors Δx_M and Δy_M of the selected sample cup (19') in the measurement coordinate system (40) thus derive as:

$\Delta x_M = x_{VB} - x_{VM}$

$\Delta y_M = y_{VB} - y_{VM}$

Every pixel (36) has a video datum (VD) of, for example, 8 bits characterizing the respective gray scale value allocated to it, so that a total of 254 gray scale values can be distinguished between “black” (VD=0) and “white” (VD=255). By filtering or with thresholds, the gray scale values can be reduced such to two values that, for example, the video datum VD = 0 is allocated to those pixels that fall onto the generated surface of the printing cylinder (1) and the video datum VD = 1 is allocated to those pixels that fall onto the cup areas of the sample cup (19). The contour (density discontinuity) of a cup area is thereby characterized by the change of the video datum from “0" to “1" or from “1" to “0".

For automatically determining the image coordinate values x_{VB} and y_{VB} of the measuring location (41) of the selected sample cup (19') in the image coordinate system (37), for example, a stripe-shaped measurement field (42) is defined that can be shifted across the video image and that can be aligned with an arbitrary orientation in the image coordinate system (37).

The measurement field (42) is composed of at least one measurement line (43), preferably of a plurality of measurement lines (43) proceeding parallel to one another, and each measurement line (43) comprises a plurality of pixels (36) whose position in the image coordinate system (37) is respectively defined by an image coordinate pair x_{VMP} and y_{VMP}, so that the position in the image coordinate system (37) can also be determined for each pixel (36) within the measurement lines (43). The longitudinal expanse of the measurement field (42) amounts to at least the same as the spacing of two engraving lines (21). The spacings of the pixels (36) from one another respectively represent a length increment. By counting the pixels (36) within a measurement distance (44), the length of the measurement distance (44) can thus be measured as a multiple of the length increment.

Figure 3 shows the formation of a stripe-shaped measurement field (42) that, for example, is composed of a measurement lines [sic] (43) with fourteen pixels (36).

Figure 4 shows the formation of a quadratic measurement field (42) that, for example, is composed of 6 measurement lines (43) with respectively 6 pixels (36) in each measurement line (43).

As already explained, the edges of the cup area of a sample cup (19) in the registered video image (35) form a contour (45). The measurement distance (44), for example for measuring the maximum transverse diagonal or the maximum longitudinal diagonal of the sample cup (19), thus derives from the respective spacing of the corresponding contours (45) from one another.

The end pixels (36', 36") of the measurement distance (44) are advantageously determined with the assistance of the measurement field (42) itself on the basis of an automatic recognition of two neighboring contours (45), in that the respective video data (VD) of two successive pixels (36) of the measurement line (43) are investigated for a change of the video data (VD).

Figure 5 shows the measurement band (42) with one measurement line (43) and two contours (45) spaced from one another. The video data (VD) allocated to the individual pixels (36) are also shown, whereby the contours (45) are characterized by the change "0' to "1" and "1" to "0". The corresponding end pixels (36', 36") of the measurement distance (44), which is composed of 9 pixels (36) in the illustrated case, are determined by an automatic contour recognition.

Figure 6 shows the measurement of the image coordinate value x_{VB} of the measurement location (41) of the selected sample cup (19') with the stripe-shaped measurement field (42), which is composed of one measurement line (43). In the illustrated example, the measurement location (41) is the mid-point of the cup area of the selected sample cup (19'). The measurement field (42) has its longitudinal expanse aligned in the direction of the abscissa of the image coordinate system (37) and is shifted onto the selected sample cup (19'). The end pixels (36', 36") of the measurement distance (44) are determined by the automatic recognition of the contour (45) of the cup area of the selected sample cup (19'). The plurality of pixels (36) that devolve onto the measurement distance (44) is thus known, and the middle pixel (360 of the measurement distance (440 then represents the measurement location (41) of the selected sample cup (19'). The image coordinate value x_{VB} of the measurement

location (41) of the selected sample cup (19') in the image coordinate system (37) then derives as coordinate value of the middle pixel of the measurement distance (44).

Figure 7 shows the corresponding measurement of the image coordinate value y_{VB} of the measurement location (41) of the selected sample cup (19') with the measurement field (42) that has its longitudinal expanse aligned in the direction of the ordinate of the image coordinate system (37) for this purpose. In the illustrated example, the measurement location (41) is again the mid-point of the cup area. The image coordinate value y_{VB} of the measurement location (41) of the selected sample cup (19') then derives from the identified coordinate value of the middle pixel (36) of the measurement distance (44).

Advantageously, the selected sample cup (19') that represents a defined hue is automatically "sought" in the video image (35) with the assistance of a measurement field (42) composed of a plurality of measurement lines (43). To that end, the cup area of the sample cup (19') is prescribed according to the predetermined hue as a plurality of pixels (36). A corresponding measurement field is shown in Figure 4. The size of the measurement field (42) at least corresponds to the size of the predetermined cup area, so that all pixels (36) falling into the cup area can be covered by the measurement field (42). The measurement field (42) is shifted across the video image (35) from engraving location to engraving location of the sample cups (19). At every engraving location, the cup area of the appertaining sample cup (19) is measured with the assistance of the measurement field (42) in that the pixels (36) counted in the individual measurement lines (43) are added up and compared to the pixel plurality of the predetermined cup area. A sample cup (19) has been identified as selected sample cup (19') when the predetermined and the measured cup area agree.

In a method step **[E]**, the measured position errors Δx_M and Δy_M are compensated by displacing the measurement carriage (23) and/or by turning the printing cylinder (1). The compensation can ensue manually under visual control of the video image on the control monitor (27) or with an automatic control of cylinder drive (2) and/or engraving carriage drive (7) via the controller (14). The image evaluation unit (23) thereby supplies a corresponding control command (S_4) to the controller (14) via a line (33) when the evaluation of the video image has yielded that

the measurement location (41) of the selected sample cup (19') is congruent with the coordinate origin (38) of the measurement coordinate system (40), as a result whereof an exact determination of the geometry values of the engraved sample cups (19) is assured.

Figure 8 shows the video image (35) after the correction of the position errors Δx_M and Δy_M. The measurement location (41) of the selected sample cup (19') is now congruent with the coordinate origin (38) of the measurement coordinate system (40) in the video image (35).

In most instances, it suffices to merely compensate the axial position error Δx_M by shifting the measurement carriage (23) since a plurality of sample cups (19) for a hue are usually engraved in engraving line direction and, thus, at least one sample cup (19) of a hue lies in the pickup area of the video camera (24).

After compensation of the position errors Δx_M and Δy_M, the determination of the geometry values of the engraved sample cups (19) ensues in a method step **[F]** with an automatic evaluation in the image evaluation unit (26) of the video image (35) according to Figure 8 registered with the video camera (24). The measurement is advantageously implemented with the assistance of the same measurement field (42) that was already employed for the measurement of the position errors Δx_M and Δy_M.

For measuring the maximum transverse diagonal (d_{Qmax}), which corresponds to the measurement distance (44) in Figure 6, or an arbitrary transverse diagonal (d_Q) of a sample cup (19), the measurement field – as already shown in Figure 6 – has its longitudinal expanse aligned in the direction of the abscissa of the measurement coordinate system (40).

For measuring the maximum longitudinal diagonal (d_{Lmax}), which corresponds to the measurement distance in Figure 7, or an arbitrary longitudinal diagonal (d_L) of a sample cup (19), the measurement field (42) – as shown in Figure 7 – has its longitudinal expanse aligned in the direction of the ordinate of the measurement coordinate system (40).

For measuring the pilot cut (d_{DS}), i.e. the width of the engraving channel in the direction of the abscissa of the measurement coordinate system (40) that connects two sample cups (19) engraved on an engraving line (21), the measurement field (42)

again has its longitudinal expanse aligned in the direction of the abscissa. The measurement of the pilot cut (d_{DS}) is graphically shown in Figure 9.

For measuring the web width (d_{SB}), i.e. the width of the material that has remained standing between two deep cups engraved on neighboring engraving lines (21, 21'), the measurement field is expediently turned such that it has its longitudinal expanse aligned approximately perpendicularly to the course of the web. The measurement of the web width (d_{SB}) is graphically shown in Figure 10.

Figure 11 schematically shows an electronic engraving machine for engraving printing forms with a second exemplary embodiment for a measuring device for measuring engraved sample cups (19).

In this exemplary embodiment, the video camera (24) – differing from what is shown in Figure 1 – is not arranged on a separate measurement carriage (23) but on the engraving carriage (7) next to the engraving element (3) with a structurally conditioned axial spacing B from the engraving stylus (4) of the engraving element (3). The video image (35) of the engraved sample cups (19) is picked up, for example, via a lightguide cable whose light entry face is arranged in a plane proceeding perpendicular to the axial direction and through the tip of the engraving stylus (4) of the engraving element (3). Alternatively thereto, the video image (35) of the engraved sample cups (19) can also be directly registered with the video camera (24). In this case, the video camera (24) mounted on the engraving carriage (5) is first shifted by the axial distance B onto the predetermined measurement position in the sample engraving region (20) with the engraving carriage drive (7) after engraving the sample cups (19). Subsequently, the position errors Δx_M and Δy_M are measured and corrected and the engraved sample cups (19) are measured.

Figure 12, in summary, schematically shows the work execution at an engraving machine, whereby it is assumed that the video camera (24) is mounted next to the engraving element (3) on the engraving carriage (5) according to the exemplary embodiment according to Figure 11.

a) Displacing the engraving element (3) with the engraving carriage (5) onto a predetermined, axial rated position (47) of an engraving line (21) to be

engraved and engraving of sample cups (19) on an engraving line (21) in an axial actual position (48) that, due to an axial position error Δx, deviates from the rated position (47), according to method steps **[A]** and **[B]**.

b) Positioning the video camera (24) to the predetermined measurement position (47), which coincides with the predetermined rated position (47) of the engraving line (21), by displacing the engraving carriage (5) according to method step **[C]**.

c) Measuring the position error Δx of the video camera (24) in the predetermined measurement position (47) according to method step **[D]**.

d) Correction of the position error Δx of the video camera (24) by displacing the engraving carriage (5) into a new measurement position (48) according to method step **[E]** and

e) measuring the engraved sample cups (19) that were engraved on the engraving line (21) in the actual position (48) at the new measurement position (48) of the video camera (24) according to method step **[F]**.

The method can preferably also be utilized in the engraving of a plurality of engraving lanes lying juxtaposed in axial direction on a printing cylinder with a respectively allocated engraving element and in what is referred to as the twin mode of the engraving machine.

When engraving a plurality of engraving lanes on a printing cylinder (1) with a respectively allocated engraving element (3), a separate sample engraving must be implemented for each engraving element (3). For measuring the sample engravings, let the engraving machine be equipped with the displaceable measurement carriage (23) with the video camera (24) according to the exemplary embodiment of Figure 1. For measuring the individual sample engravings in each engraving lane, the video camera (24) is respectively axially displaced onto the individual measurement positions by the width of an engraving lane. In this case, the above-explained method steps **[A]** through **[F]** are implemented in every measurement position. Of course, a

video camera according to the exemplary embodiment of Figure 11 can also be allocated to each engraving element (3).

In what is referred to as the twin mode of an engraving machine, two printing cylinders (1, 1*) are mechanically coupled to one another, these being engraved with a respective engraving element (3, 3*). The engraving element (3, 3*) are mounted on the shared engraving carriage (5) with a fixed spacing from one another, said engraving carriage (5) moving axially along both printing cylinders (1, 1*). A sampling engraving is engraved on the appertaining printing cylinder (1, 1*) with each engraving element (3, 3*). For measuring the sample engravings, let the engraving element (3, 3*) comprise a video camera (24, 24*) on the engraving carriage (5) next to each engraving element (3, 3*) according to the exemplary embodiment of Figure 11. A modified work sequence derives in this case.

Figure 13 schematically shows the modified work sequence at an engraving machine working in twin mode, whereby it is assumed that a respective video camera (24, 24*) is mounted on the shared engraving carriage (5) next to the engraving element (3, 3*) according to the exemplary embodiment of Figure 11.

a) Displacing the engraving elements (3, 3*) with the shared engraving carriage (5) onto predetermined, axial rated position (47, 47*) of engraving lines (21, 21*) to be engraved and engraving sample cups (19, 19*) on the engraving lines (21, 21*) in axial actual positions (48, 48*) that deviate from the rated positions (47, 47*) due to axial position errors Δx and Δx^*, according to method steps **[A]** and **[B]**.

b) Positioning the first video camera (24) to a predetermined, first measurement position (47) that coincides with the predetermined, first rated position (47) of an engraving line (21) by displacing the shared engraving carriage (5) according to method step **[C]**.

c) Measuring the position error Δx of the first video camera (24) in the predetermined, first measurement position (47) according to method step **[D]**.

d) Correcting the measured position error Δx of the first video camera (24) by displacing the shared engraving carriage (5) into a new first measurement position (48) according to method step **[E]**.

e) Measuring the geometry values of the sample cups (19) engraved on the first printing cylinder (1) that were engraved on the engraving line (21) in the first actual position (48) at the new, first measurement position (50) of the first video camera (240 according to method step **[F]**.

f) Measuring the position error Δx^* of the second video camera (24*) in the momentary position of the shared engraving carriage (5) according to method step **[D]**.

g) Calculating a new position error Δx^*_{new} for the second video camera (24*).

h) Correcting the calculated position error Δx^*_{new} of the second video camera (24*) into a new, second measurement position (48*) by displacing the shared engraving carriage (5) according to method step **[E]**, and

i) measuring the geometry values of the sample cups (19) engraved on the second printing cylinder (1*) that were engraved on the engraving line (21*) in the second actual position (48*) at the new, second measurement position (50*) of the second video camera (24*) according to method step **[F]**.

Patent Claims

1. Method for generating and evaluating a sample cut in an electronic engraving machine for engraving printing cylinders for rotogravure, whereby

- a engraving control signal (GS) for driving the engraving stylus (4) of an engraving element (3) is formed from engraving data (GD), which represent hues to be engraved between "light" and "dark", and a periodic raster signal (R) for generating an engraving raster,
- the engraving stylus engraves a sequence of cups arranged in the engraving raster into the printing cylinder (1) engraving line by engraving line, the geometry values of said cups determining the engraved hues,
- sample cups (19) for predetermined hues are engraved before the actual engraving,
- a video image (35) of the sample cups (19) is registered with a video camera (24),
- the geometry values of sample cups (19) are determined in the video image (35) and compared to the geometry values of the predetermined hues, and
- the engraving control signal (GS) is calibrated such dependent on the comparison result that the engraved hues correspond to the predetermined hues,

characterized in that

- the video camera (24) is positioned to a predetermined, axial measurement position;
- one of the engraved sample cups (19') is selected;
- the positional deviation of a measurement location (41) of the selected sample cup (19') from a reference location (39) in the video image (35) is identified as position error (Δx_M and Δy_M);
- the identified position errors (Δx_M and Δy_M) are corrected such by axial displacement of the video camera (24) into a new measurement position and/or by turning the printing cylinder (1) that the measurement location

(41) of the selected sample cup (19') lies at least in the region of the reference location (39) of the video image (35); and

– the geometry values of at least the selected sample cup (19') are subsequently measured.

2. Method according to claim 1, characterized in that a sample cup (19') representing a mid-hue between “light” and “dark” is selected.

3. Method according to claim 1 or 2, characterized in that the measurement location (41) is the area mid-point of the selected sample cup (19').

4. Method according to claim 1 or 2, characterized in that the measurement location (41) is the mid-point of the transverse diagonals or of the longitudinal diagonals of the selected sample cup (19')

5. Method according to claim 1 or 2, characterized in that the measurement location (41) is the mid-point of the pilot cut or of the web of the selected sample cup (19').

6. Method according to at least one of the claims 1 through 5, characterized in that the reference location (39) for determining the positional deviation of the selected sample cup (19') in the video image (35) lies in the middle of the image.

7. Method according to at least one of the claims 1 through 6, characterized in that the reference location (39) for determining the positional deviation of the selected sample cup (19') in the video image (35) is the coordinate origin of a measurement coordinate system (40) in the video image.

8. Method according to at least one of the claims 1 through 7, characterized in that the video image (35) is subdivided into pixels (36); and in that the position of the pixels (36) in the video image (35) is defined by coordinates (x_V, y_V) of a video coordinate system (37) allocated to the video image (35).

9. Method according to at least one of the claims 1 through 8, characterized in that

– the video image (35) is subdivided into pixels (36);

– a measurement field (42) displaceable across the video image (35) is generated;

- the measurement field (42) comprises at least one measurement line (43) with a plurality of pixels (36) whose position in the video image (35) is defined by the coordinates (x_V, y_V) of the video coordinate system; and
- the length of a measurement distance (44) in the video image (35) is determined as a plurality of pixels (36) of the measurement line (43).

10. Method according to at least one of the claims 1 through 9, characterized in that the measurement field (42) is fashioned stripe-shaped.

11. Method according to at least one of the claims 1 through 10, characterized in that the measurement field (42) can be arbitrarily oriented in the video image (35).

12. Method according to at least one of the claims 1 through 11, characterized in that the measurement distance (44) corresponds to the spacing of two contours (45) belonging to a sample cup (19) from one another.

13. Method according to at least one of the claims 1 through 12, characterized in that the contours (450 of a sample cup (19) are recognized by an automatic evaluation of the video image (35).

14. Method according to claim 13, characterized in that the contours (45) of a sample cup (19) are recognized by means of at least one measurement line (43) of the measurement field (42).

15. Method according to claim 14, characterized in that

- every pixel (36) of the video image (35) has a video datum (VD) allocated to it that identifies whether the appertaining pixel (36) is a component part of a sample cup (19) or not;
- the video data (VD) of respectively two successive pixels (36) of the measurement line (43) of the measurement field (42) are investigated for a change; and
- an identified change of the video data (VD) is recognized as contour (45).

16. Method according to at least one of the claims 1 through 15, characterized in that the selected sample cup (19') is automatically recognized in the video image (35) with the assistance of the displaceable measurement field (42).

17. Method according to claim 16, characterized in that

– the size of the cup area of the selected sample cup (19') is prescribed;

– a measurement field (420 is defined whose size corresponds at least to the cup area of the selected sample cup (19');

– the measurement field (42) is shifted across the video image (35) from sample cup to sample cup;

– the cup area of the respective sample cup (19) is measured in every position of the measurement field (42) and compared to the prescribed cup area; and

– a sample cup (19) is recognized as selected sample cup (19') given at least approximate area coincidence.

18. Method according to claim 17, characterized in that

– the size of the cup area of the selected sample cup (19') is prescribed as a plurality of pixels (36);

– the measurement field (42) comprises a plurality of measurement lines (43) aligned parallel to one another;

– the cup area of a sample cup (19) is determined by adding up the pixels (36) in the individual measurement lines (43) that fall into the cup area; and

– the prescribed plurality of pixels (36) is compared to the measured plurality of pixels (36) in the area comparison.

19. Method according to at least one of the claims 1 through 18, characterized in that the measurement location (41) of the selected sample cup (19') and its position in the video image (35) is automatically determined with the assistance of the displaceable measurement field (42).

20. Method according to claim 19, characterized in that the measurement location (41) is the area mid-point of the selected sample cup (19'); and in that the transverse diagonal or the longitudinal diagonal of the selected sample cup (19') is measured with the measurement field (42) as measurement distance (44), whereby the area mid-point derives as half transverse diagonal or half longitudinal diagonal.

21. Method according to at least one of the claims 1 through 20, characterized in that

– two printing cylinders (1, 1*) coupled to one another are engraved with a respective engraving element (3, 3*);

– the engraving elements (3, 3*) are arranged on a shared engraving carriage (5);

– a video camera (24, 24*) is allocated to each engraving element (3, 3*);

– the first video camera (24) is positioned to a predetermined, first measurement position (47);

– the axial position error (Δx) of the first video camera (24) is measured in the predetermined, first measurement position (47);

– the measured axial position error (Δx) of the first video camera (24) is corrected by displacing the shared engraving carriage (5) into a new, first measurement position (48);

– the geometry values of the sample cups (19) engraved on the first printing cylinder (1) are measured at the new, first measurement position (50) of the first video camera (24);

– the axial position error (Δx*) of the second video camera (24*) in the momentary position of the shared engraving carriage (5) is measured;

– a new axial position error (Δx^*_{new}) is calculated for the second video camera (24*);

– the calculated, axial position error (Δx^*_{new}) of the second video camera (24*) is corrected by displacing the shared engraving carriage (5) into a new, second measurement position (48*); and

– the geometry values of the sample cups (19) engraved on the second printing cylinder (1*) are measured at the new, first measurement position (50) of the first video camera (24).

22. Method according to at least one of the claims 1 through 21, characterized in that sample cups (19) for the hues “light”, “dark” and at least one “mid-hue” are engraved in the sample engraving.

23. Method according to at least one of the claims 1 through 22, characterized in that the sample cups (19) for the hues “light”, “dark” and “mid-hue” are respectively engraved on neighboring engraving lines (21).

24. Method according to at least one of the claims 1 through 23, characterized in that at least one sample cup (19) is engraved on each engraving line (21).

25. Method according to at least one of the claims 1 through 24, characterized in that the geometry values to be measured are the transverse diagonals, the longitudinal diagonals, the pilot cuts, the web widths or the cup areas of the engraved sample cups (19).

26. Method according to at least one of the claims 1 through 25, characterized in that the stripe-shaped measurement field (42) has its longitudinal expanse arranged transversely, preferably perpendicularly, to the course of the web in the measurement coordinate system (40) for measuring web widths.

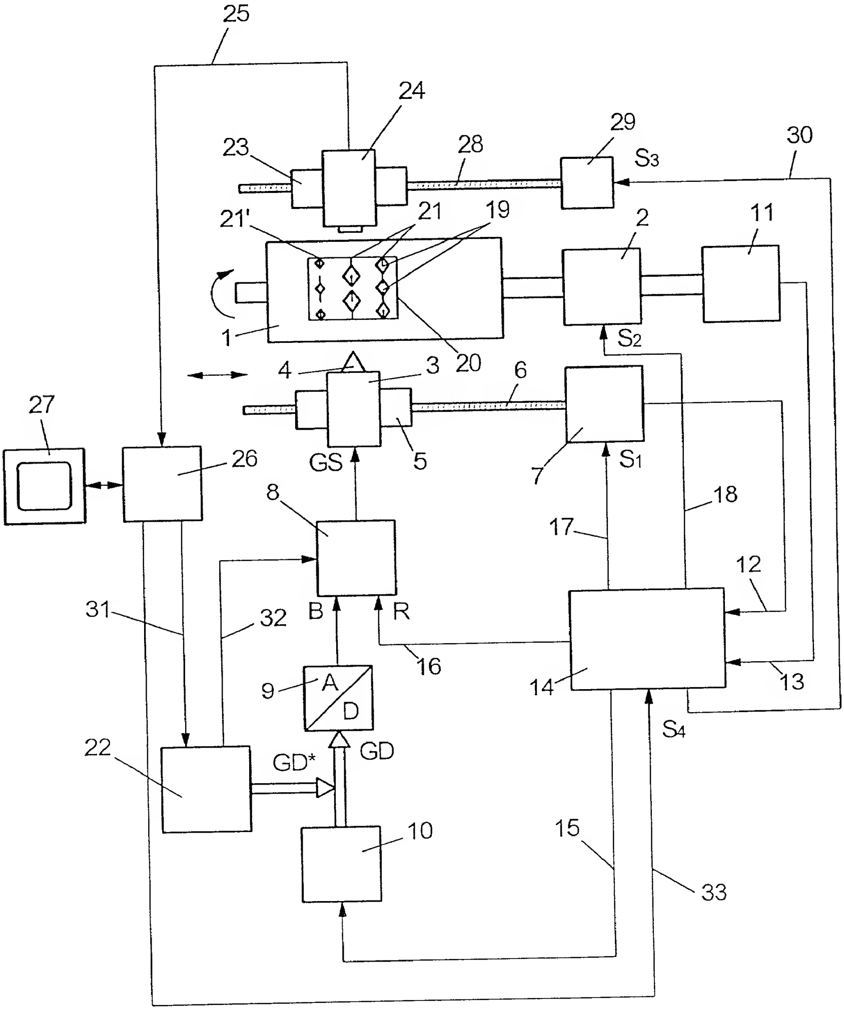
27. Method according to at least one of the claims 1 through 26, characterized in that

– the measurement field (42) comprises a plurality of measurement lines (43) arranged parallel to one another;
– the measured results achieved with the individual measurement lines (43) are compared to one another; and
– for enhancing the measuring dependability, the measured result of a measurement line (43) is forwarded only given agreement of the measured results compared to one another.

28. Method according to at least one of the claims 1 through 27, characterized in that

– the measurement field (42) comprises a plurality of measurement lines (43) arranged parallel to one another;
– the measured results achieved with the individual measurement lines (43) are subjected to an extreme value selection; and
– only the greatest or smallest measured result is forwarded.

29. Method according to at least one of the claims 1 through 28, characterized in that the measurement field (42) is employed both for the measurement of the positional deviation of the selected sample cup (19') as well as for the measurement of the geometry values of the sample cups (19).



25
24
23
28
29
S3
30
21'
21
19
2
11
1
20
S2
4
3
6
27
26
GS
5
7
S1
8
18
17
12
31
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R
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14
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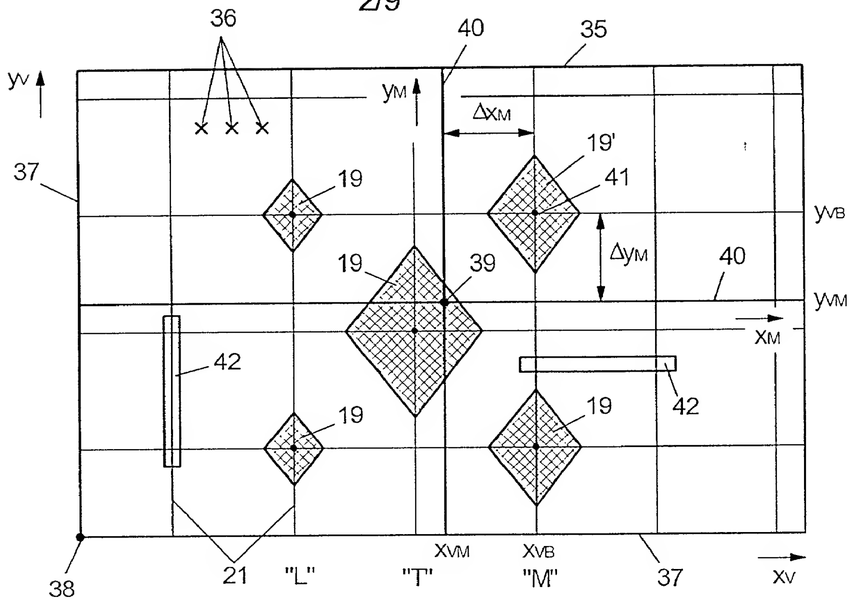
9
A
D
S4
22
GD*
GD
10
15
33

Fig. 1



36
40
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y_V
y_M
Δx_M
19'
41
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y_{VB}
Δy_M
19
39
40
y_{VM}
x_M
42
42
19
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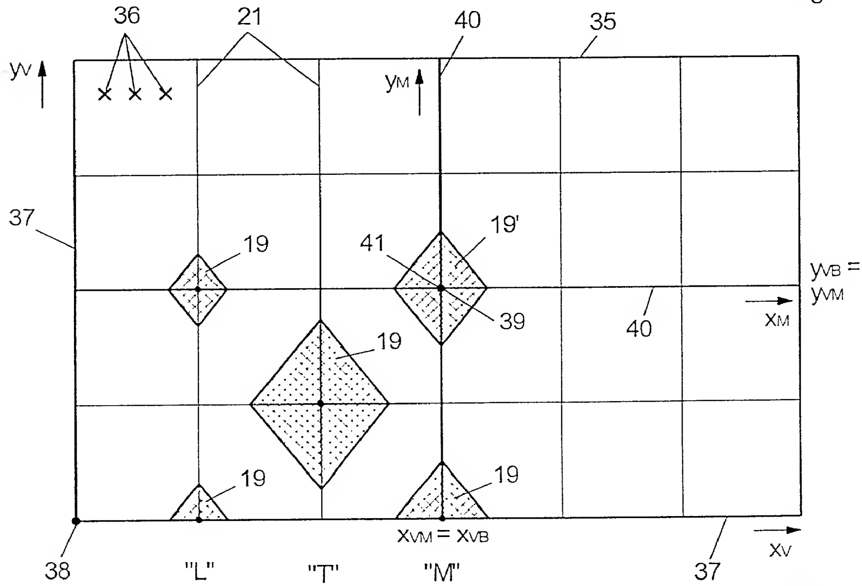
38
21
"L"
"T"
x_{VM}
x_{VB}
"M"
37
x_V

Fig. 2



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21
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35
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y_{VM}
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"M"
37
x_V

Fig. 8

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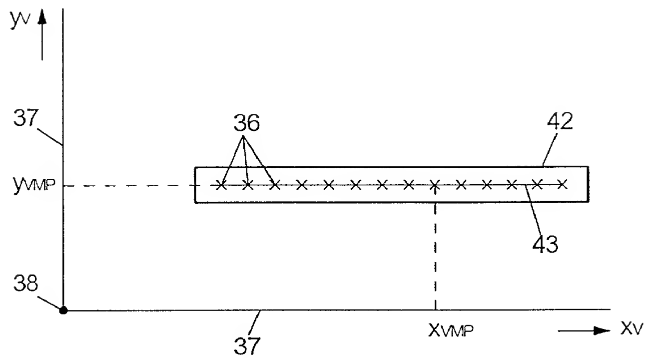


Fig. 3

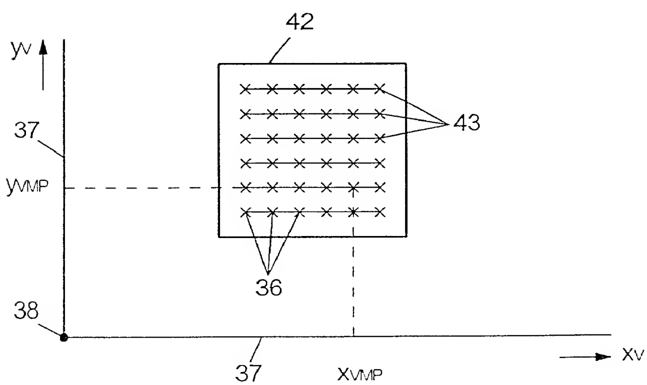
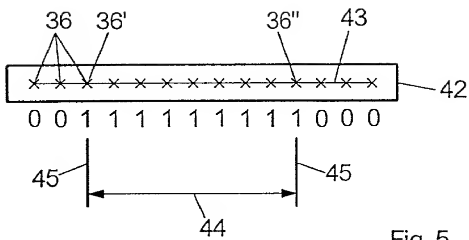


Fig. 4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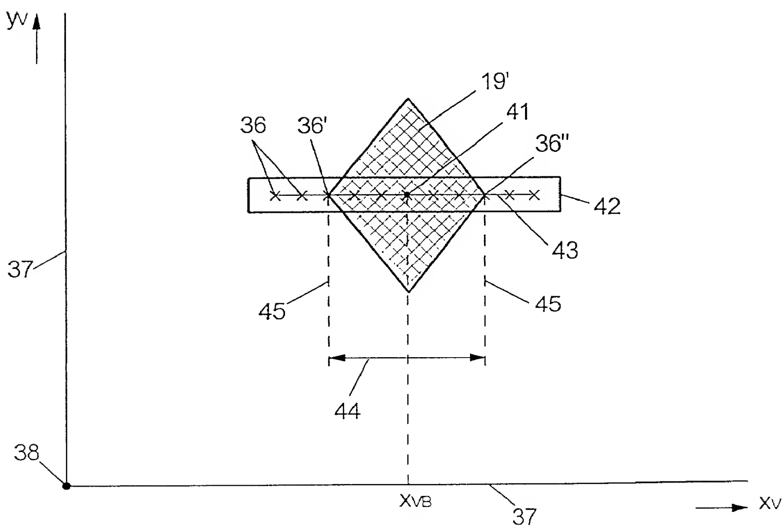
44

Fig. 5


yw
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36'
36''
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43
37
45
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38
XVB
37
XV

Fig. 6

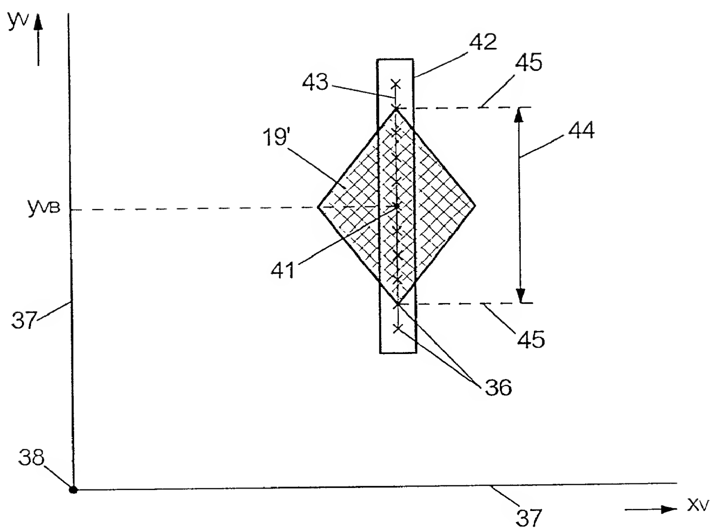


Fig. 7

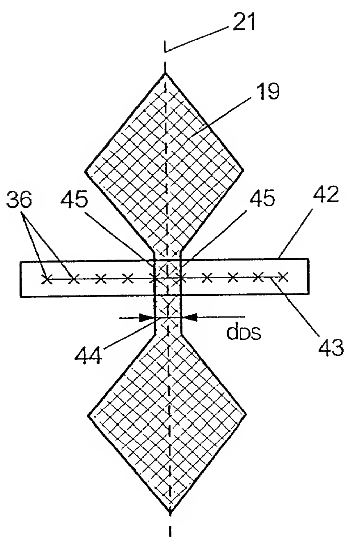


Fig. 9

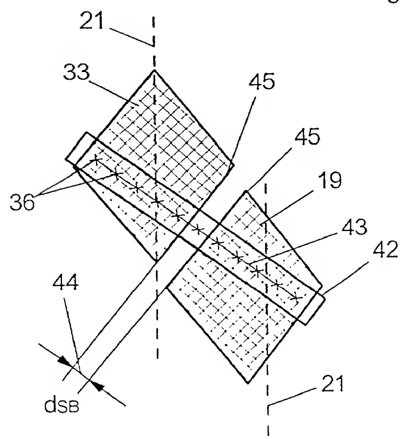
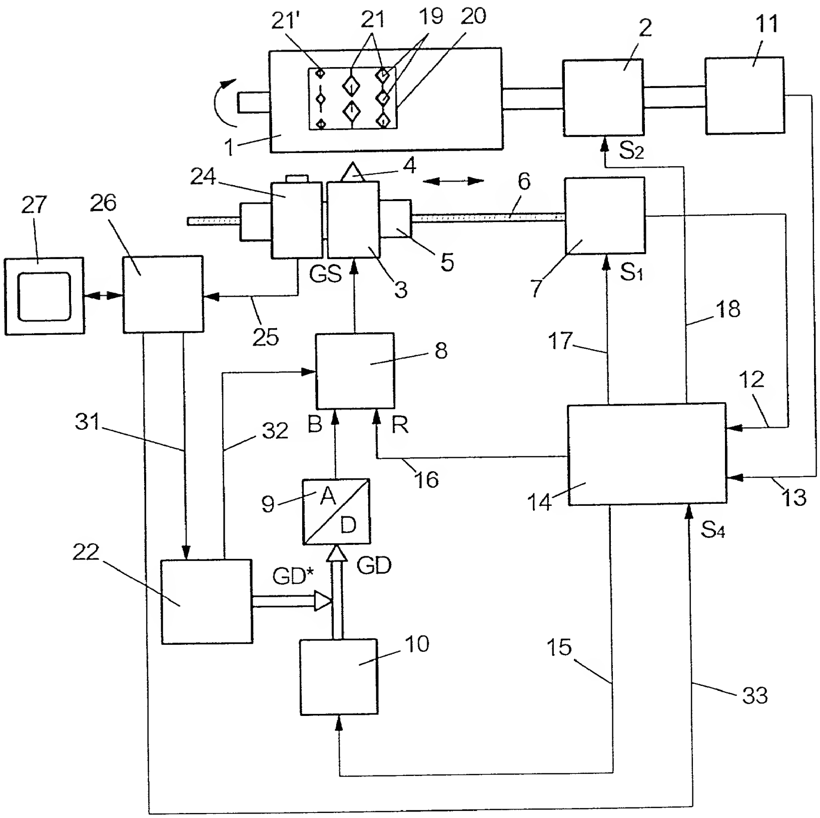


Fig. 10


21'
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GS
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S1
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S4
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GD*
GD
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Fig. 11

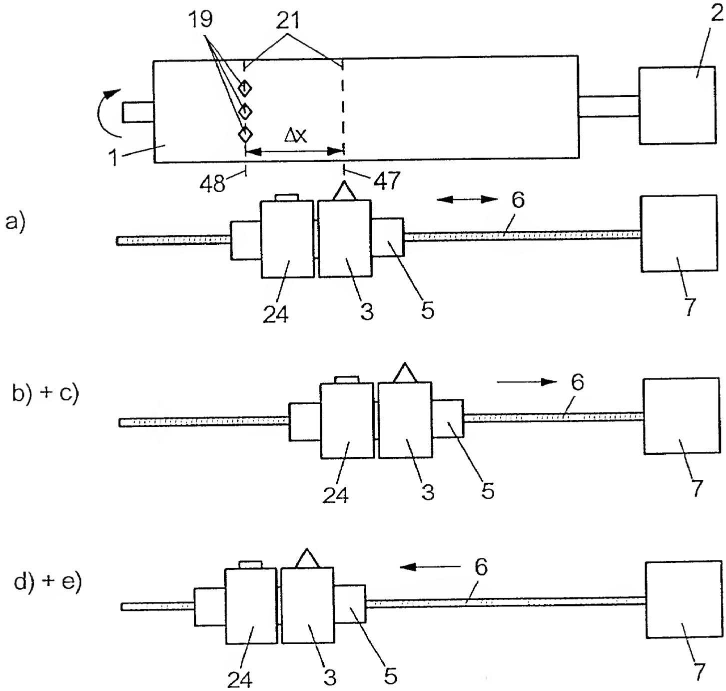

Fig. 12

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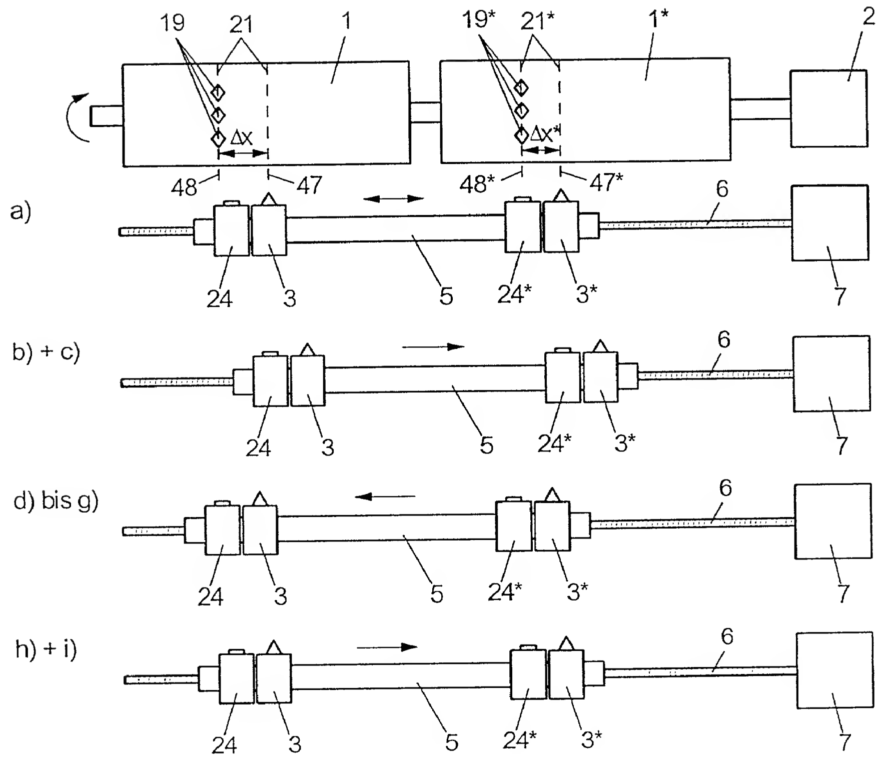

Fig. 13

COMBINED DECLARATION FOR PATENT APPLICATION AND POWER OF ATTORNEY (Includes Reference to PCT International Applications) PCT/DE99/02175	ATTORNEY'S DOCKET NUMBER P00,1911

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name, I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

"METHOD FOR GENERATING AND EVALUATING A SAMPLE ENGRAVING"

the specification of which (check only one item below):

☐ is attached hereto.

☐ was filed as United States application Serial No. ______________________

on ______________________,

and was amended

on ______________________(if applicable).

■ was filed as PCT international application

Number **PCT/DE99/02175**

on **14 July 1999**,

and was amended under PCT Article 19

on ______________________(if applicable).

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, §1.56(a).

I hereby claim foreign priority benefits under Title 35, United States Code, §119 of any foreign application(s) for patent or inventor's certificate or of any PCT international application(s) designating at least one country other than the United States of America listed below and have also identified below any foreign application(s) for patent or inventor's certificate or any PCT international application(s) designating at least one country other than the United States of America filed by me on the same subject matter having a filing date before that of the application(s) of which priority is claimed:

PRIOR FOREIGN/PCT APPLICATION(S) AND ANY PRIORITY CLAIMS UNDER 35 U.S.C. 119:

COUNTRY (if PCT indicate "PCT")	APPLICATION NUMBER	DATE OF FILING (day, month, year)	PRIORITY CLAIMED UNDER 35 USC 119
GERMANY	**198 35 303.0**	**05 August 1998**	■ YES ☐ NO
			☐ YES ☐ NO
			☐ YES ☐ NO
			☐ YES ☐ NO
			☐ YES ☐ NO

Combined Declaration For Patent Application and Power of Attorney (Continued)
(Includes Reference to PCT International Applications) **PCT/DE99/02175**

ATTORNEY'S DOCKET NO. **P00,1911**

I hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s) or PCT international application(s) designating the United States of America that is/are listed below and, insofar as the subject mater of each of the claims of this application is not disclosed in that/those prior application(s) in the manner provided by the first paragraph of Title 35, Untied States Code, §112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, §1.56(a) which occurred between the filing date of the prior application(s) and the national or PCT international filing date of this application:

PRIOR U.S. APPLICATIONS OR PCT INTERNATIONAL APPLICATIONS DESIGNATING THE U.S. FOR BENEFIT UNDER 35 U.S.C. 120:

U.S. APPLICATIONS		STATUS (Check one)		
U.S. APPLICATION NUMBER	U.S. FILING DATE	PATENTED	PENDING	ABANDONED

PCT APPLICATIONS DESIGNATING THE U.S.					
PCT APPLICATION NO	PCT FILING DATE	U.S. SERIAL NUMBERS ASSIGNED (if any)			

POWER OF ATTORNEY: And I hereby appoint Messrs. John D. Simpson (Registration No. 19,842), Steven H. Noll (28,982), Brett A. Valiquet (27,841), James D. Hobart (24,149), Melvin A. Robinson (31,870), and Mark Bergner (45,877), all members of the firm of Schiff, Hardin & Waite

Send Correspondence to:

SCHIFF HARDIN & WAITE
Patent Department
71st Floor Sears Tower, Chicago, Illinois 60606

Direct Telephone Calls to:
312/258-5500
Ext. **5786**

201	FULL NAME OF INVENTOR	FAMILY NAME **Weidlich**	FIRST GIVEN NAME **Ernst-Rudolf**	SECOND GIVEN NAME **Gottfried**
	RESIDENCE & CITIZENSHIP	CITY **Kiel** DEX	STATE OR FOREIGN COUNTRY **GERMANY**	COUNTRY OF CITIZENSHIP **GERMANY**
	POST OFFICE ADDRESS	POST OFFICE ADDRESS **Fliegender Hollander 29**	CITY **24159 Kiel**	STATE & ZIP CODE/COUNTRY **GERMANY**
202	FULL NAME OF INVENTOR	FAMILY NAME	FIRST GIVEN NAME	SECOND GIVEN NAME
	RESIDENCE & CITIZENSHIP	CITY	STATE OR FOREIGN COUNTRY	COUNTRY OF CITIZENSHIP
	POST OFFICE ADDRESS	POST OFFICE ADDRESS	CITY	STATE & ZIP CODE/COUNTRY
203	FULL NAME OF INVENTOR	FAMILY NAME	FIRST GIVEN NAME	SECOND GIVEN NAME
	RESIDENCE & CITIZENSHIP	CITY	STATE OR FOREIGN COUNTRY	COUNTRY OF CITIZENSHIP **SWEDEN**
	POST OFFICE ADDRESS	POST OFFICE ADDRESS	CITY	STATE & ZIP CODE/COUNTRY

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

SIGNATURE OF INVENTOR 201 Ernst-Rudolf Gottfried Weidlich	SIGNATURE OF INVENTOR 202	SIGNATURE OF INVENTOR 203
DATE 01/31/01	DATE	DATE